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What Feed Shall I Use?

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Supplementing his previous article, "How Long Between Grinds?" and a progress report, "Can the Cutting of Metals Be Made a Science?" by the subcommittee of which he is secretary, the author now gives an analysis of machine feeds as related to cutting efficiency

EVERY MAN who has any intimate connection with a machine shop has his own ideas as to the amount of feed that should be used in machining a particular piece, but unfortunately, there are almost as many different ideas as there are men. These ideas are based on the experience of the individual and are seldom, if ever, more than rough and ready approximations. Certainly there is little enough data as to the best feed to be used under a given set of circumstances, when it is desired to secure the lowest possible over-all cost.

The conclusions presented in this article were prepared with the belief that it was possible to calculate the effect of the feed used on over-all cost. It was realized at the outset that the calculations would be somewhat difficult because of the lack of dependable data as to the effect of tool size and shape, depth of cut and feed on the cutting speed when machining a particular material. Far too much of the available data is in so general a form that it is of little real value. It is not generally realized that tool size, shape, material, and heat-treatment, depth of cut and feed used and desired tool life under cut, as well as machinability of the metal cut, all affect the cutting speed, and that there is a single speed which may be used under a given set of conditions. Where a single cutting speed is given, it cannot take all these variables into consideration, and consequently is probably much lower than could be used a large part of the time, as it must be suitable for heavy cuts which are not taken more than a portion of the time.

It is extremely important for the metal-working industry to be thoroughly familiar with the way in which variations in the major elements in a metal cutting set-up affect the total cost of the piece produced. Usually the amount of metal to be removed and consequently the depth of cut, is fixed by the design of the part and by the dimensions of the bar, casting or forging from which it is to be made. The tendency is to use stock which requires a minimum removal of stock to form the finished piece, both to reduce the machining time, and to diminish the weight of stock which must be used.

In a previous article "How Long Between Grinds?" (*AM*—Vol. 77, page 517), the effect of varying the tool life between grinds was investigated. The parts used to illustrate that investigation, which were chosen to represent a wide range of turning operations, may well be used in this instance. However, while in that article it was possible to use existing data to a certain extent, it was thought advisable to discard these data for the present investigation, as they were not believed to be sufficiently accurate.

Study of available data on the cutting of metals has indicated that the pioneer work of Frederick W. Taylor is still more complete and reliable than that available from any other source. For this reason the data contained in "On the Art of Cutting Metals" were used as a basis for a new set of tables, which represent, as closely as possible, the cutting speeds which should be attainable with properly hardened present-day tool steels and tools of the size and shape adopted. SAE 1045 steel was used as the material for all three illustrative parts. This steel was used as a matter of convenience, since data were available on the machinability of such a steel from the metal-cutting demonstration held at Stevens Institute of Technology in honor of the fiftieth anniversary of Taylor's graduation from that school. It was decided to make all computations on the basis of dry cutting, also for the sake of convenience.

In the previous article it was determined that a tool life under cut of 30 min. gave minimum costs for two engine lathe jobs and 120 min. gave minimum cost for a screw machine operation, so that all machining times were based on the use of these tool lives.

Inasmuch as forged nose tools, as recommended by Taylor, seem to be seldom used at the present time, in spite of the advantages which may be secured from their use, it was thought desirable to adopt a compromise form of tool nose, which may be readily formed by grinding and which gives satisfactory cutting performance. This tool form, shown in Figs. 2 and 6, is quite extensively used in England, Germany and Sweden. Such a tool is only three and a half per cent less efficient in cutting performance than the corresponding Taylor tool and has a slightly reduced tendency to chatter. Inasmuch as the nose of the Taylor tool is forged to give both a raised and an offset tool nose, it is somewhat more efficient in the use of tool material and has a smaller tendency to upset in the toolholder than the tool illustrated.

Because the available data indicates

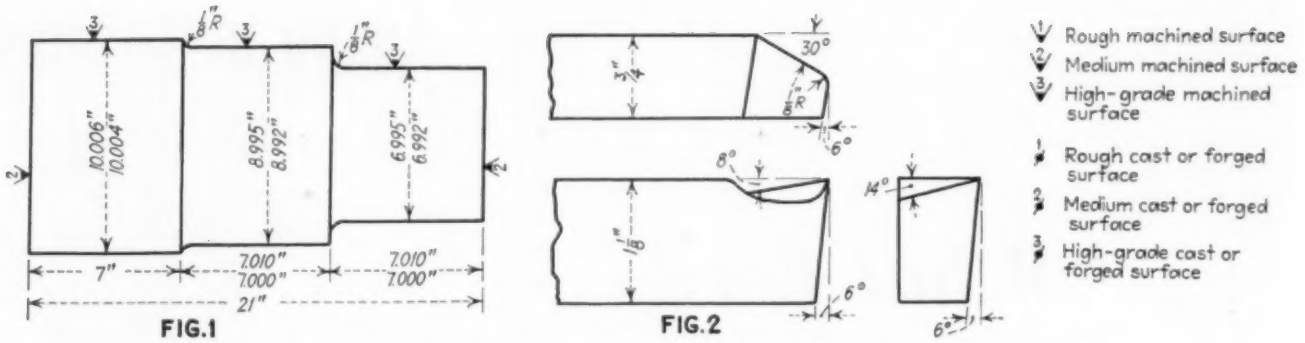


Fig. 1—A heavy turning job similar to a locomotive crankpin was used for the first example. Fig. 2—Dimensions of the roughing tool used in the work shown in Fig. 1

Table I—Total Job Costs for Work Shown in Fig. 1

Figured for the use of feeds from 0.005 to 0.100 per revolution in machining steel. Job shown in Fig. 1, with cutting speeds based on 30 min. tool life under cut

Feed	No. of grinds necessary per piece	Time consumed by machine operator per piece produced, in minutes				Tool grinding @ 2.6 min. per grind, min.	Cost per piece									
								Direct Labor			Overhead					
		Changing dull tools @ 1.7 min. per change	Handling time	Machining time	Total		Tool cost	Tool grinding	Lathe operation	Total	Tool grinding	Lathe operation	Total	Total fixed cost	Total variable cost	Total cost
0.005	9.1	15.4	61.3	272.0	348.7	23.6	0.121	0.275	3.778	4.053	0.472	10.180	10.652	2.452	12.376	14.826
0.010	6.6	11.4	61.3	201.0	273.7	17.4	0.087	0.203	2.963	3.166	0.348	7.970	8.318	2.452	9.119	11.571
0.020	5.0	8.5	61.3	150.3	220.1	13.0	0.066	0.152	2.385	2.537	0.260	6.425	6.685	2.452	6.836	9.288
0.030	4.2	7.1	61.3	124.5	192.9	10.8	0.056	0.126	2.087	2.213	0.216	5.620	5.836	2.452	5.653	8.105
0.040	3.7	6.3	61.3	111.5	179.1	9.7	0.049	0.113	1.942	2.055	0.194	5.230	5.424	2.452	5.076	7.528
0.050	3.4	5.7	61.3	100.5	167.5	8.7	0.045	0.102	1.816	1.918	0.174	4.880	5.054	2.452	4.565	7.017
0.060	3.1	5.3	61.3	93.2	159.8	8.1	0.041	0.095	1.730	1.825	0.162	4.660	4.822	2.452	4.236	6.688
0.070	2.9	4.9	61.3	86.0	152.2	7.5	0.038	0.088	1.650	1.738	0.152	4.440	4.592	2.452	3.916	6.368
0.080	2.7	4.6	61.3	81.2	147.1	7.0	0.036	0.082	1.597	1.679	0.140	4.290	4.430	2.452	3.693	6.145
0.090	2.5	4.3	61.3	76.4	142.0	6.6	0.033	0.077	1.540	1.617	0.132	4.140	4.272	2.452	3.470	5.922
0.100	2.4	4.1	61.3	73.1	138.5	6.3	0.032	0.074	1.501	1.575	0.126	4.040	4.166	2.452	3.321	5.773

Tool dimensions.....$\frac{3}{4}$x1$\frac{1}{8}$x14 in.
Minimum length of shank.....5 in.
Usable length of shank.....9 in.
No. of dressings per tool.....10
No. of regrindings per dressing.....17
Total number of grinds per tool.....170

Cost of tool @ 0.60 per lb.....$2.00
Cost of heat-treatment.....$0.25
Total cost of tool.....$2.25
Cost of tool, per grind $\frac{2.25}{170}$.....$0.0132
Time to grind tool.....2.6 min.

	Overhead Rate	Direct labor rate
Lathe operation.....	1.75	0.65
Tool grinding.....	1.20	0.70

that a high proportion of the metal-cutting in the United States is being done with high-speed steel tools ("Can Metal-Cutting be Made a Science?", progress report of the A.S.M.E. sub-committee on metal-cutting data, *AM*—Vol. 77, page 782) and because the data on high-speed steel tools are more reliable than on other tool materials, all work is based on high-speed steel tools of the standard 18-4-1 composition, hardened at approximately 2,400 deg. F.

While the constant cost in machining the parts, based on the handling operations, is of little importance in determining the effect of change in the feed used, to maintain consistency, the times required for these operations were determined from available unit time study data, which represent average working conditions under scientific management, when wage incentives are employed. An attempt was made to take a range of feeds which would be greater than would be found in ordinary practice, so that the practical operating condition would lie somewhere between the two extremes.

The part illustrated in Fig. 1 is similar to a locomotive crankpin which is completely machined from bar stock in an engine lathe. The $\frac{3}{4}$x1$\frac{1}{8}$-in. roughing tool shown in Fig. 2 was used for all roughing cuts, and a similar tool was used for the finishing cuts.

It was necessary first to calculate the time required for each operation. As the handling times are identical, regardless of the feed used, these times were determined but once, and an allowance for personal and general needs added to give the figure found in Column 4. It was necessary to calculate the machining time separately for each feed, as there is no general multiplying factor which may be used. These figures were increased by an allowance for personal and general needs before being placed in Column 5.

The number of grinds necessary per piece, found in Column 2, was determined by dividing the machining time per piece by 30, the tool life between grinds which had been previously determined.

The time required for changing dull tools was obtained by multiplying 1.7 min., the time necessary for a single tool change, by the number of tool changes necessary. Actually, it is doubtful whether a good mechanic would find it desirable to change tools because of wear in the case of a part such as that shown in Fig. 1, as he would change tools between cuts, even if the worn tool did not have its edge entirely destroyed. This would reduce the time required by the lathe operator and increase the tool cost, as well as the time required for tool grinding. These two factors should tend to equalize each other, to give substantially the same cost as would be obtained by the more theoretical method.

The total time consumed by the lathe hand would be the sum of the handling and machining time plus the time required for the changing of dull tools. The tool grinding time is obtained by multiplying the number of grinds necessary per piece by 2.6 minutes, the time required for grinding a single tool. A tool cost per grind of $0.0132 is obtained, by dividing the sum of the steel cost and the cost of hardening, by the number of grinds which may be obtained from a single tool.

Direct labor costs are based on assumed hourly rates of $0.65 per hour for lathe hands, and $0.70 per hour for tool grinders. It is believed that these rates represent a fair average under scientific management, including the bonuses paid by any wage incentive that is in use.

The labor cost per piece for each

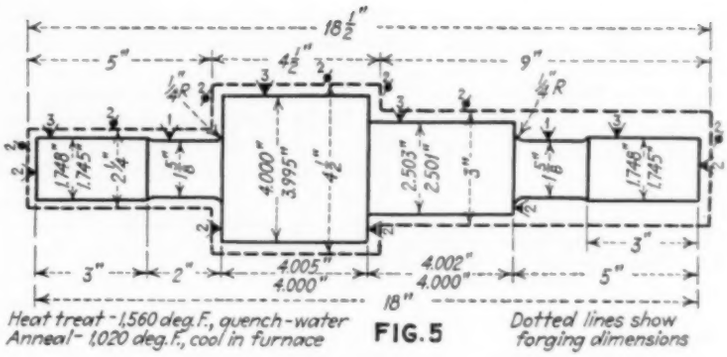


FIG. 5

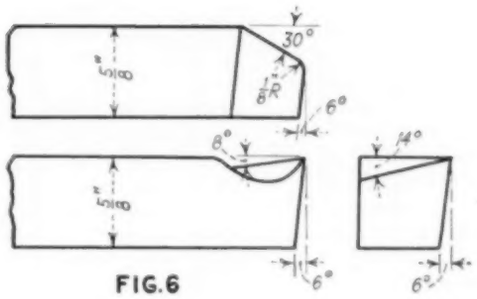


FIG. 6

Fig. 5—Shaft turning job from a steel forging used as the second typical workpiece. Fig. 6—Dimensions of toolbit used for the work shown in Fig. 5

Table III—Costs for Different Feeds on Work Shown in Fig. 5

Varying from 0.005 to 0.100 in. per revolution, in machining steel.
Job shown in Fig. 4, with 30 min. tool life under cut.

Feed	No. of grinds necessary per piece	Time consumed by machine operator per piece produced, in minutes					Cost per piece					
		Changing of dull tools	Tool grinding	Handling time	Machining time	Total	Tool cost	Direct labor	Overhead	Total variable cost	Total fixed cost	Total
0.005	1.4	1.7	3.4	50.5	42.4	98.0	0.015	1.061	2.860	1.916	2.020	3.936
0.010	1.0	1.2	2.9	50.5	29.7	84.3	0.011	0.913	2.460	1.364	2.020	3.384
0.020	0.7	0.8	1.7	50.5	21.8	74.8	0.008	0.810	2.185	0.983	2.020	3.003
0.030	0.6	0.7	1.7	50.5	18.0	70.9	0.007	0.768	2.070	0.825	2.020	2.845
0.040	0.5	0.6	1.4	50.5	16.1	67.6	0.005	0.732	1.971	0.688	2.020	2.708
0.050	0.5	0.6	1.4	50.5	14.5	67.0	0.005	0.726	1.953	0.664	2.020	2.684
0.060	0.4	0.5	1.2	50.5	13.3	65.5	0.004	0.710	1.911	0.605	2.020	2.625
0.070	0.4	0.5	1.2	50.5	12.1	64.3	0.004	0.696	1.878	0.558	2.020	2.578
0.080	0.4	0.5	1.2	50.5	11.5	63.7	0.004	0.690	1.858	0.532	2.020	2.552
0.090	0.4	0.5	1.2	50.5	11.1	63.3	0.004	0.686	1.849	0.519	2.020	2.539
0.100	0.4	0.5	1.2	50.5	10.5	62.7	0.004	0.678	1 829	0.491	2.020	2.511

Tool bit dimensions ..... ½ x ½ x 4½ in.
Minimum length of shank ..... 1½ in.
Usable length of shank ..... 3 in.
No. of dressings per tool ..... 3 in.

No. of regrindings per dressing 16
No. of regrindings per tool 48
Cost of tool bit @ $1.05 per lb. weight ¼ lb. 0.52

Cost of tool per grind $0.52 ÷ 48 = $0.0108
Direct labor rate ..... $0.65 per hour
Overhead rate ..... $1.75 per hour

operation is obtained by multiplying the equivalent time, from Columns 6 and 7, by the proper wage rate, and dividing by 60 in the usual way. The total labor cost per piece is the sum of the lathe operation and tool grinding costs. Overhead rates of $1.75 per hour for lathe operation and $1.20 per hour for tool grinding have been assumed to conform as near as possible with average conditions under scientific management. The overhead cost per piece for each operation has been calculated, using these rates, the times given in Columns 6 and 7 and then summarized. The total cost per piece is then calculated by adding the tool cost, direct labor cost, and the overhead cost per piece, and set down in Column 17. The total fixed cost, given in Column 15, includes both direct labor and overhead costs of the handling time, Column 4, while the variable costs, Column 16, include the cost of the tool plus the direct and overhead cost of the tool changing, machining and tool grinding times, Columns 3, 5, and 7.

A curve, Fig. 3, is then plotted, showing the total processing cost of the part as a function of the feed. It will be seen that the total cost drops rapidly, but that the rate decreases as the feed is increased, particularly after a feed of 0.030 to 0.040 in. per rev. has been reached. While the cost continually becomes lower as the feed is increased, it drops only 15 per cent as the feed is increased from 0.060 to 0.100 in. In view of the difficulties which are usually encountered when attempting to take heavy feeds when turning steel, it will be necessary to have rather complete data as to the equipment available before deciding just what is the best procedure to follow. Incidentally, the cutting horsepower for a cut ⅜ in. deep, and 0.060 in. feed is nearly thirteen, so that it would require a machine equipped with at least a 15-hp. driving motor to carry this cut, as it requires at least 3 hp. to run the lathe idle. The transverse strength of the tool must also be considered.

For each operation, the cutting speed has been used which will give a 30-min. tool life under cut. Table II shows the cutting horsepower for the tool shown in Fig. 2, taking a cut ⅜ in. deep in SAE 1045 steel used for all three illustrative parts.

These data have been plotted on the

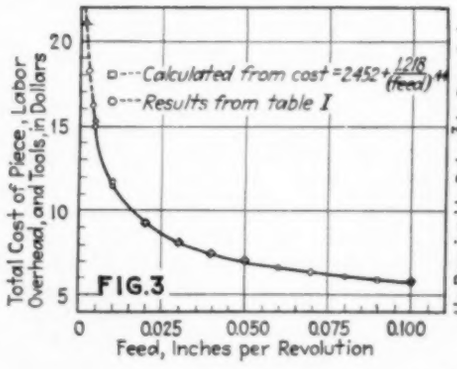


FIG. 3

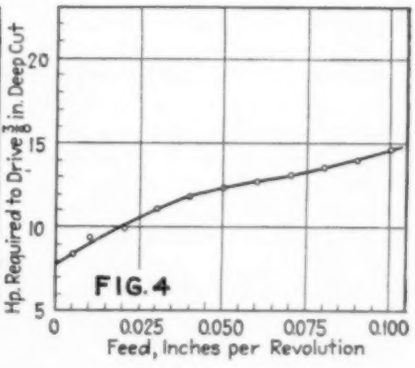


FIG. 4

Fig. 3—Relation between feed and total cost on a heavy turning job. Fig. 4—Relation between feed and horsepower required for a ⅜ in. cut in SAE 1045 steel.

Table II

Feed	Cutting Horsepower
0.005	8.39
0.010	9.32
0.020	9.90
0.030	11.18
0.040	11.82
0.050	12.40
0.060	12.70
0.070	13.12
0.080	13.49
0.090	13.95
0.100	14.57

curve in Fig. 4. While this curve is the reverse of that in Fig. 3, its similarity in form is evident and suggests that the machining cost is in some way inversely proportional to the horsepower required to remove the chip.

Part 2, shown in Fig. 5, is considerably lighter than the first one considered. As it is assumed that a forging is used as stock, there is not so great a volume of metal to be removed as in the case of the first part. A $\frac{5}{8}$x $\frac{5}{8}$-in. tool bit, ground into the form shown in Fig. 6, held in an Armstrong toolholder and made of a standard 18-4-1 high-speed steel, is used for machining this part, which is finished complete on the lathe without grinding. It has been further assumed that the lathe operator grinds his own tools, using a conveniently located floor stand, so that he does not find it necessary to waste much time in walking between lathe and tool grinder. As the lathe operator does all tool grinding, and it is not necessary to dress or harden the tool bits used, all direct labor is performed by him.

The calculations on which Table III are based are similar to those used in figuring Table I, and the same labor and overhead rates are used. The data on which the cost of the tool are based are somewhat of an estimate, as no published data has been found as to the number of grinds which are possible from a tool of this size. Because of the higher per pound cost of steel when furnished in the form of bits, it will be seen that the cost per grind of a $\frac{5}{8}$-in. bit is nearly as high as the similar cost for the $\frac{3}{4}$x$\frac{1}{8}$-in. tool used in the first illustration.

Results are plotted in Fig. 7 and give a curve which is similar in form to that shown in Fig. 3. In this case, it is particularly desirable to hold the feed to a moderate value, as the tool will withstand safely a pressure of approximately only 1,100 lb. As a cut $\frac{5}{8}$ in. deep by 0.040 in. feed sets up a tangential pressure of approximately 4,000 lb., it will be seen that this point must be carefully considered when the smaller tools are used. It is believed that the allowable tool pressure could be appreciably increased if the tool were supported almost directly under the cut, and if a somewhat better clamping mechanism were employed on top of the bit, such as is now used only for stellite bits, in order to prevent concentration of stress under the clamping screw.

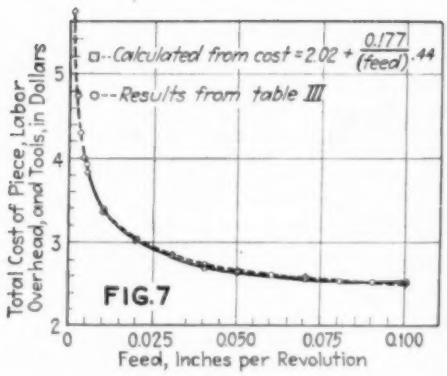


Fig. 7—Relation between feed and total cost for Example 2

Accurate Shoulder Grinding

C. H. HILL

In precision cylindrical grinding trouble is often experienced in getting shoulders exactly square or 90 deg. with the axis of the work being ground.

After a grinding machine becomes so badly worn that it will not produce square shoulders within manufacturing limits, the cause of the error can be located at one or more of the following points. The headstock and footstock should be checked to see that the axes of the centers are in plane with each other and with the axis of the grinding wheel spindle. The centers should be checked to see that they are an exact fit in the center holes, the points smooth and exactly 60 deg., and that both the headstock and footstock ways and the headstock and footstock table ways are square and smooth.

Many operators and some executives often wonder why it is necessary to adjust the swivel table every time the headstock or footstock is moved in order to make the machine grind work straight. This trouble is caused by practically the same condition as the one that causes the machine to grind shoulders out of square.

In order to locate these errors it is necessary to follow the right procedure to secure the best results. To check the horizontal and vertical alignment of the headstock and footstock, place a perfectly round and straight bar between the centers of the machine, then with an indicator clamped on the wheel side, move the table back and forth and it will show the inaccuracies in the centers as well as in any other part of the machine that is causing this particular trouble.

The centers should be checked for fit by bluing the tapers and trying them in the center holes. Centers should be ground in a special fixture that will hold them so that the points will be ground concentric with the body. This keeps the point in plane with both the axes of the centers and the grinding wheel spindle. The fixture should be so made that the centers will be free from chatter and exactly 60 deg. Then the points should be ground off slightly so that they will not bottom in the center holes of the work. Do not expect good work from a machine equipped with poor centers.

After a grinding machine has been used for a period of time on short work where the table traverse is only a few inches the base ways will become worn so when the machine is changed over to accommodate long work the pieces will come large in the center. This is caused by the table dropping into the worn section of the base ways as it passes over it, the work being below the center of the grinding wheel. To prevent this trouble shift the headstock and footstock occasionally to different parts of the table; the only cure, after the damage has been done, is to rescrape the base ways.

Steel Ways and Scraping Discussion

ROBERT S. ALEXANDER

I agree with Charles Northey's contention (*AM*—Vol. 78, page 222) that in the matter of ground or scraped bearing surfaces, "the question of chips and swarf is not one of surface, but of efficient management in seeing that costly machines are kept properly clean." Here, I submit, lies the answer to the problem of bearing surface conservation; cleanliness and efficient lubrication. Therefore, I believe that if ground bearing surfaces are properly protected and lubricated by any modern method which insures the right amount of oil in the right place, there can be no question as to the ultimate saving effected by grinding instead of scraping.

In considering the factor of longevity, in evaluating the worth of even the most costly machine tool, we cannot afford to overlook the fact that with few exceptions obsolescence limits its profitable productive life to five years' service. If we look at the bearing problem from this angle it must be agreed that the case for the ground surface is strengthened considerably.

Varied Practice in Surface Broaching

FRED H. COLVIN
Editor, American Machinist

ALTHOUGH internal broaching is a standard machining operation in many shops, it is only within recent years that much attention has been paid to linear or outside surface broaching. Occasional instances of surface broaching have been known for some time, but consistent progress in this line is of recent origin. Without attempting to allot priority in this development, we are pleased to be able to show some of the work now being done in regular production operations

Broaching machines are made in horizontal, vertical and rotary forms and operated both mechanically and hydraulically. In most cases the broaches are moved past the work, but this procedure is being reversed in some of the later types of machines.

Inside broaches are supported and to some extent guided by the work itself. But with many outside broaches, both the broach and work must be supported against the side thrust of the cut. The work holding fixtures must be designed not only to locate the work but to hold it against both the pull of the broach in the cut and against the thrust away from the teeth. This of course refers to cuts on one side of the work only. When opposite sides of a piece are broached, the cuts tend to balance each other as in internal broaching.

As might be expected, much of the pioneer work in this line has been done in the automobile field. A job of this kind is seen in Figs. 1, 2 and 3, which show a late machine of the American Broach & Machine Co., Ann Arbor, Mich. Fig. 1 shows the double fixture in the loading position. The work is held back against its face by jaws on each side, operated by the handles shown. After loading, the whole fixture is rolled down into the position in Fig. 2, which shows the broaches at the lower end of the stroke. The dimensions of the work and the amount of metal removed are seen in Fig. 3. The machine is semi-automatic in operation and the cycle is completed in approximately 18 sec. giving two pieces at once, or approximately 6 pieces per minute. The fixture changes from loading to working position and back again, as a part of the regular operation cycle. Tilting and positioning of the fixture is done by an hydraulic cylinder, enclosed in the left side of the work table. The fixture is automatically tripped at the completion of the cutting stroke. The fixture then comes up to have the work removed and to be loaded with the next pieces.

Connecting rod bolt boss contours are now being broached on Oilgear machines by automobile engine builders as shown in Fig. 4. This shows how two rods are held in the machine while both bosses are broached to the desired shape, at one pass. Each broach removes from 1/32 to 1/16 in. of stock and one machine, with one operator, finishes from 700 to 750 rods per hour. In this case, the broach replaces a special machine that cost approximately $17,000. The maximum output of the special machine was 1,225 pieces per hour, but the investment was six times that of the complete broaching equipment.

Teeth in steering sectors are broached in the holder shown in Fig. 5. The sector shaft is held at an angle and the sectional broach is supported directly

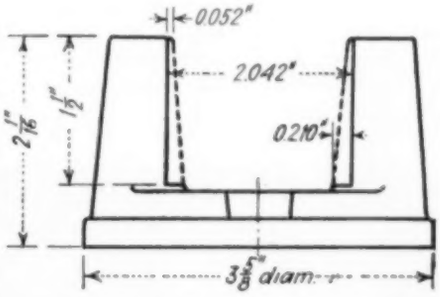


Fig. 3—Details of the work being broached. Metal removed indicated by dotted lines

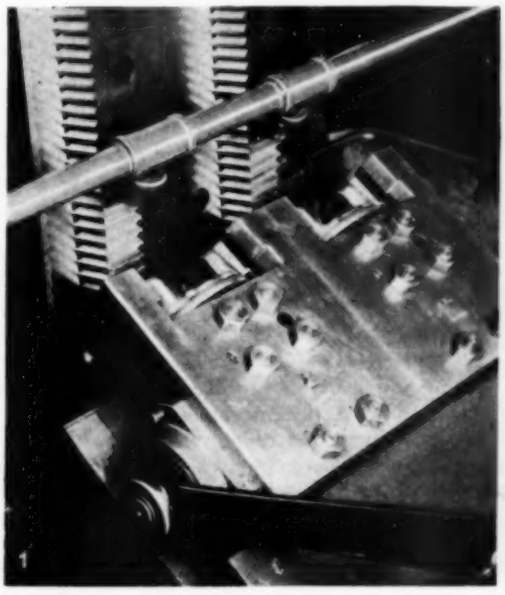
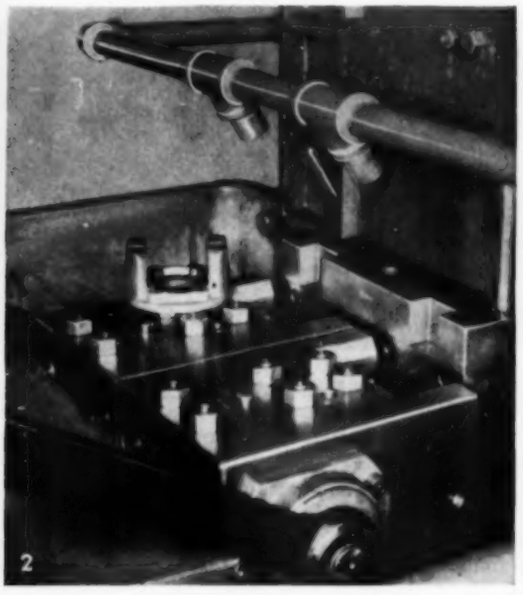


Fig. 1—Double broaching operation with the work holder tilted for insertion and removal of work. Note that side teeth cut after face is completed. Fig. 2—Fixture down in working position and broaches at lower end of stroke



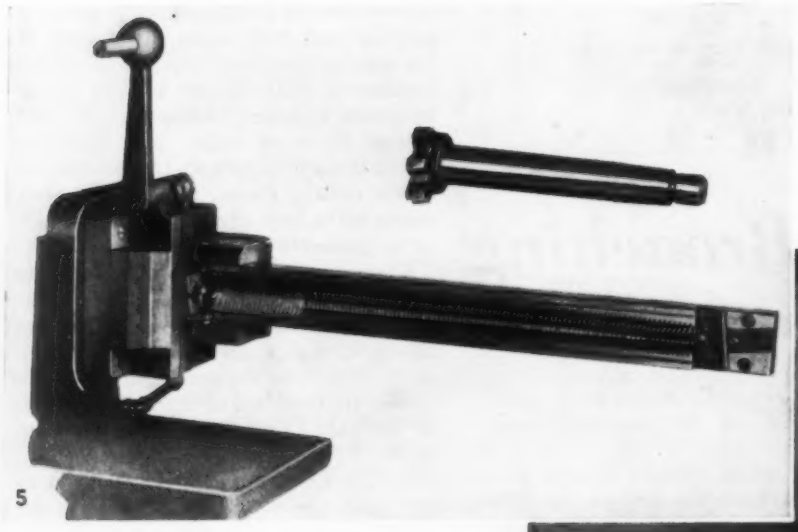
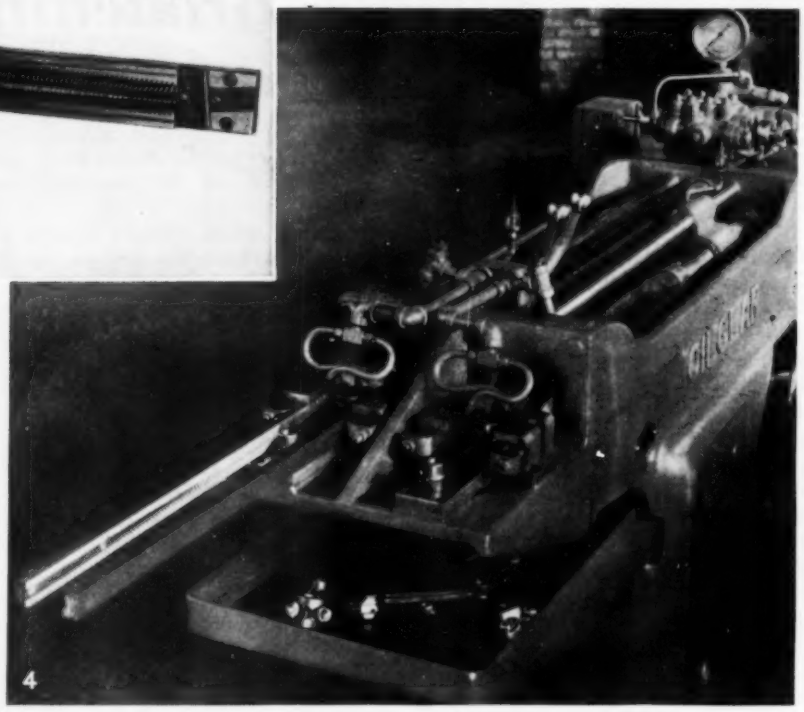


Fig. 5—Steering sector teeth are roughed out on a double spindle machine, 300 per hr.

Fig. 4—Finishing metal around bolt bosses on both sides of connecting rods at a single pass



behind the cut. With a double-broach machine, the production is from 300 to 350 pieces per hour. Where a true helix is desired, the teeth are now finished on a gear shaper. The broach takes a roughing cut of approximately 0.037 in. and leaves 0.015 to 0.020 in. for finish. While as many as 75,000 pieces have been broached at one grind of the cutter, it is general practice to grind them at between 60,000 and 65,000 pieces. At this rate the probable life of cutting tools is from 800,000 to 900,000 pieces per set of inserts.

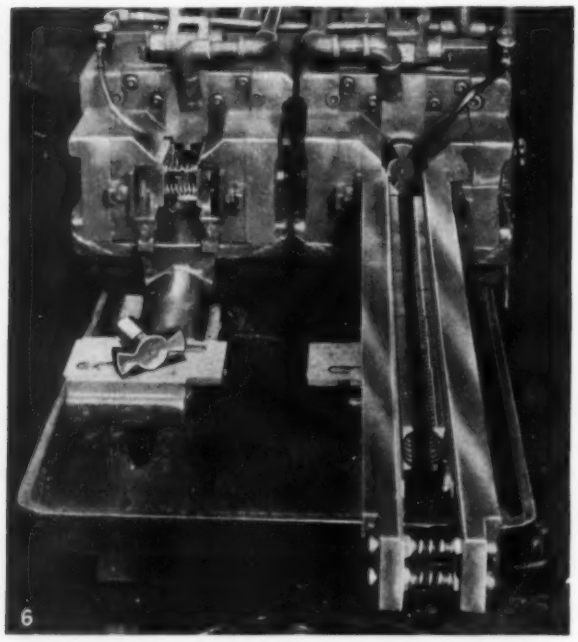


Fig. 6—Broaches for these shock absorber vanes are held apart by springs at end until they come inside guides in machine bed

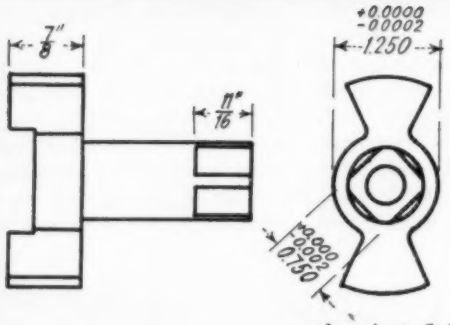


Fig. 7—Details of the oscillating vane in shock absorber to show general dimensions and tolerances demanded

These steering sectors are of alloy steel. Cast iron segments, for washing machines and similar uses, can be cut at a higher rate.

Vanes for use in rotating type shock absorbers are made of molybdenum steel and require very accurate machining. Both the separate wing and the mating wing and shaft are broached, either on horizontal or vertical machines. They are broached from the rough, removing about 0.060 in. stock from each side to a tolerance of 0.0005 in. as the surfaces must be glycerine tight. The machine set up is shown in Fig. 6, where one broach is out, ready to start and the other just finishing its cut. It will be noted that two coil springs separate the broaches at the end, these being compressed by the supporting guides as the broaches are pulled over the work.

These vanes are broached at the rate of 550 to 600 pieces per hour. The broaches are ground at from 25,000 to 30,000 pieces. As originally planned, these parts were rough machined before coming to the broaches. It required thirteen roughing machines to keep one broach busy. Now the entire operation is done by broaching on the Oilgear machines.

Continuous Broaching

Broaching machines are now being developed for continuous operation. An example of this is seen in Fig. 8, which

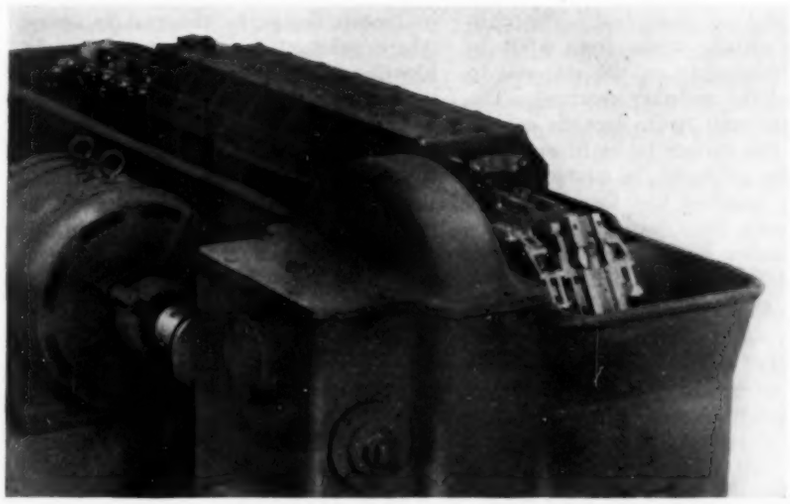


Fig. 8—Continuous broaching machine of the chain type. Fixtures are loaded as they pass into tunnel containing the broaches

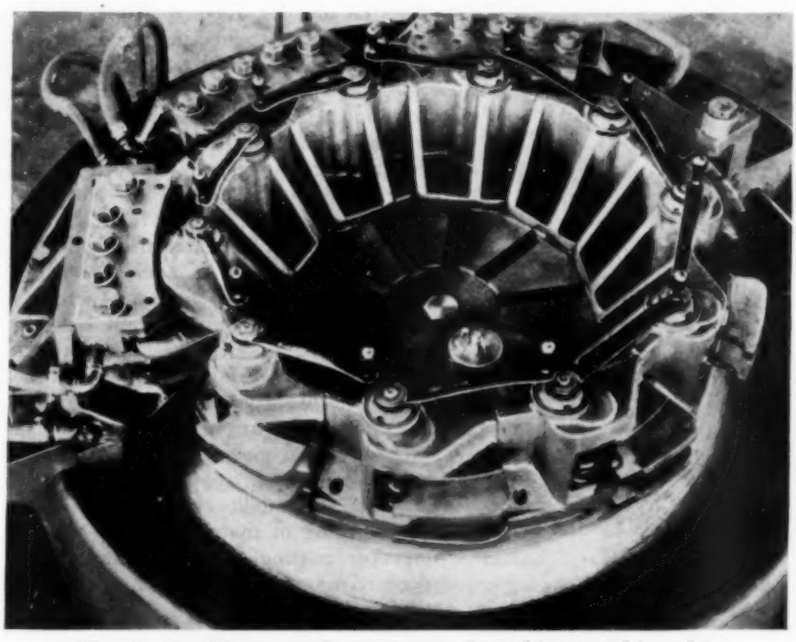


Fig. 9—In this type of continuous broaching machine the work is clamped on a rotary table and passes between stationary broaches

is a Foote-Burt machine for machining the two joint faces and the two outer ends of a connecting rod cap. The general arrangement of machine parts is shown clearly. Power is transmitted to the chain carrying the work through worm gearing and then a helical gear reduction to the driving sprocket of the chain.

The operator merely drops the piece in the fixture which locks it in place automatically before it enters the tunnel that holds the broaches. By keeping the cutting speed low, at 25 ft. per min., the average tool life is 50,000 pieces per grind, from the rough forgings. Coolant is pumped over the entire length of the broaches to clear them from chips, the chips being cleared out of the base by a conveyor on the larger machines.

Another continuous broaching unit is that of the American Broach and Machine Company, this being rotary in form, as in Fig. 9. Here the broach holders are located outside the periphery of the revolving table on which the work holders are mounted. The work

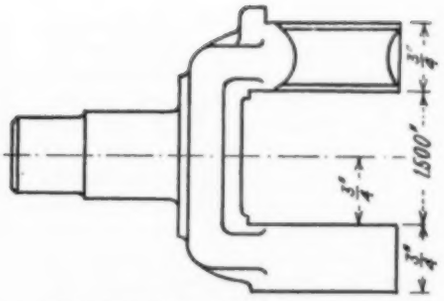


Fig. 10—Forged fork broached on rotary machine. Broaches stand up for 200,000 pieces

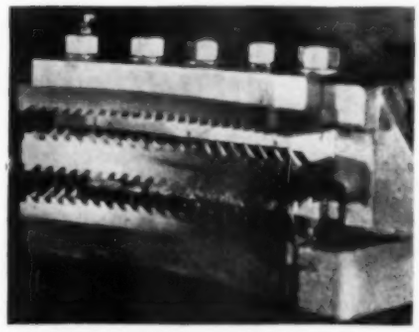


Fig. 11—One of the three sets of broaches used. This shows the shearing cut of teeth

in this case is the forked forging in Fig. 10. The forks are clamped in each of the ten holders by the crank handles shown. Fig. 11, shows one set of broaches in place in their holder. Four surfaces are machined at the same time.

The three sets of broaches divide the work to be done into roughing, second cut and finishing. By this method the holders with the second operation and the finishing broach can be moved back into the first and second positions when they become too badly worn, and a new set of finishing tools put in place. The broach teeth have a shearing cut and a production of over 200,000 pieces per set of tools is said to be assured.

The work shown is a tough forging, which is machined on four surfaces. The table carries ten work holders and revolves once a minute, but the speed can be varied according to the work. At this rate the production is 10 per minute or 600 per hour, but on other work, an output of 2,000 pieces per hour has been attained. Work is easily locked in

Summary of Broaching Practice

Work	Material	Surface in Square Inches	Pieces Per Hour	Cubic Inches Per Hour	Pieces Per Grind	Cubic Inches Per Grind	Lb. of Metal Removed Per Grind
Bearing Caps.....	C I 187	6.61	398	247	31,500	19,530	4,882
Bearing Caps.....	C I 187	4.21	772	170	35,000	7,000	1,750
Conn. Rods.....	Steel 228-255	1.85	490	42.6	21,600	1,880	470
Cylinder Block.....	C I 170-207	13.65	112	191.5	7,000	11,970	2,992

place by a slight pull of a lever and is automatically loosened after broaching is completed, by a roller that contacts the lever. The cutting speed in this particular operation, is 10 ft. per min.

The tendency in broach design is to use high speed cutting teeth, usually made up in sections that can be replaced either completely or in part, at comparatively small expense. Broaches vary greatly in length according to the amount of metal to be removed as the depth of cut per tooth is an important factor. Generally, from 12 to 60 in. covers about all broaches. The chip per tooth usually varies from 0.001 to 0.007 in. depending on the material to be cut and the accuracy required. The distance between teeth depends on the length of the surface to be broached as the number of teeth in contact affect the power required and the chip clearance. Tooth form varies as with internal broaches, both undercut, which is equivalent to top rake, of a lathe tool, and top clearance being usually desirable.

Strength is also an important factor in broach design as the pull is heavy where substantial cuts are taken. In broaching $\frac{3}{32}$ in. of metal from connecting rod ends, for example, the pull varies from 18,000 to 22,000 lb. Surface or cutting speed of broaches varies from 18 to 33 ft. per min. in practice so far noted and tolerances are held within 0.001 to 0.0005 in. The table gives a little data compiled from the paper by Joseph Geschelin for the Society of Automotive Engineers. The numbers in the second column indicate Brinell hardness.

What Makes a Successful Foreman?

SUCCESS in foremanship depends upon a number of factors. Among the most important are quality of the product and its cost. Both of these factors in turn depend upon the ability of the foreman to instill pride of workmanship in his men. This requires an understanding of the need for reliability in the product, and that men can be led much more effectively than they can be driven. Perhaps a standard for workmanship can be set up by asking oneself if the quality of work being turned out would be satisfactory if he were the purchaser.

To secure satisfactory results it is well to have a few general principles in the minds of both the foreman and his men. The foreman has the right to expect (1) cleanliness and orderliness, (2) care taken of property, equipment and materials, (3) willingness to follow instructions, (4) a fair day's work, (5) steadiness of work, (6) working well with other men. But these requirements cannot be one-sided. The men also have the right to expect certain things from the foreman, or from the plant, such as: (1) a cleanly and orderly department, (2) proper tools and equipment, (3) good materials at hand when needed, (4) proper instructions, (5) intelligent supervision, (6) adequate pay.

There is a direct relationship between these "two pairs of sixes." And though the foreman's list appears last, he must see that these conditions are fulfilled before he can expect the men to live up to the rules he provides for them. Foremen should not complain of carelessness among their men unless they are free from the same habits. In the same way they may well ask themselves if they are fulfilling the six principles that affect the men.

The sixth principle, adequate pay, is not often directly in the foreman's hands. But if he can secure adherence

WILLIAM B. WESSELS
Chief Inspector

to the six requirements laid down for the men, and does his own job satisfactorily, he should have no trouble in securing adequate pay for his men. For if he gives proper instruction and leadership and the men do their part, production costs will go down and quality will improve. If, under these conditions, he cannot get proper pay for his men, he is working in the wrong plant.

There are shops in which order and cleanliness are not considered important. These plants do not realize the effect these factors have on the men and on the product. There is, however, a kind of orderliness which involves the habit of putting away all kinds of junk with the thought that it may be useful sometime. I have seen shops with an appearance of being orderly but which had a pile of junk hidden out of sight as we used to tuck things away in the attic.

One danger of this kind of orderliness is that it cultivates the habit of putting off making decisions as to scrapping of worn out or discarded tools or parts. And this delay in making decisions is easily carried over to other matters where much depends on making decisions quickly. There is a real difference between making snap judgments and making oneself weigh both sides of a question and decide it without delay.

Accumulation of material in a department is also to be avoided where possible. If plant conditions permit, each department should be kept free of surplus material, either raw stock or finished parts. A fair supply of work to be done has a good effect on morale, but where aisles are crowded and parts stacked around machines, the confusion and disorder can easily affect both quantity and quality of the work. If the crowding of material is due to the improper routing of work through the plant it may give you the opportunity of pointing out the trouble to your own boss.

Waste is another factor for the foreman to consider. And waste includes time, energy and materials. A little self catechising as to how much of these three you waste makes a good place to start. Order is the first step in the conservation of time, energy and materials. Dirt and disorder are frequently responsible for spoiled material, or for parts being overlooked, so as to cause a shortage in the assembly.

Orderly care of tools and of machine equipment prevents damage and waste of these expensive items. Order also prevents waste of time in locating desired tools or parts, and nothing wastes energy more than the nerve strain of unnecessary movements due to disorderly arrangement.

Foremen are sometimes responsible for their men not earning more money. Lack of clear and complete instructions at the beginning of a job, and of fre-

quent inspection of the work may cause damage or spoilage. And the man loses in wages because of these failures of the foremen. True, foremen are often too busy with details to pay much attention to individual workmen. In such cases an experienced workman can perhaps be asked to keep an eye on the new man. He is not only entitled to whatever assistance he needs on his own account but because of its effect on production.

Men who can qualify on the six counts named are much more apt to be retained when forces are reduced or to get jobs when new men are hired. The same is true of foremen. Observance of the principles named make them more desirable and more likely to hold or to get positions.

This is especially true at present when there is a shortage of key men for various departments. Skilled men for boring mills, milling machines, grinders and other more or less complicated machines are now in demand. Some of the men we formerly had have gone into other lines of work or have drifted to other parts of the country. It might be well to urge your men to have any good mechanics they know get on the re-employment list at once.

In closing let me impress on all foremen and mechanics that we are all working for a common end. Indeed, we are working for each other. For we all buy products made by someone else and must depend on them to make these products satisfactory. We likewise should bear in mind that we must make our own work satisfactory to others if it is to be sold at a proper price.

Spindle Production for Accuracy and Economy

HAYWARD A. GAY

AS MODERN industry calls for greater accuracy, finer finish and larger cutting loads, the machine tool spindle becomes increasingly important. It must be machined within very close limits and be ground round and free from chatter. So that these results can be accomplished in an orderly manner and at reasonable cost, the Cincinnati Milling Machine and Cincinnati Grinders, Inc., has centralized spindle manufacture in one department. Virtually a straight-line production system has been developed.

The entire spindle department, with the exception of the normalizing and heat-treating department, is shown in Fig. 1. From the normalizing furnaces the spindle forgings are delivered to a lathe shown in the right foreground. They are then passed down the right-hand line of machines to the wall, then to the lathe located against the wall, and back up the second row of machines. After leaving the drill press at the end of the second line a burring operation is performed and heat-treating follows. Finally, the spindles are again placed in the machine line and caused to travel down the third row and back the fourth row of machines.

Rough turning is done on a LoSwing lathe, equipped with a multiple-tool, double carriage. Straight turning requires one setting and the taper turning and necking operations a second setting. All diameters are reduced approximately ½ in. to insure removal of surface defects. Rough grinding stock of 0.040 to 0.050 in. is left on all milling spindles and from 0.060 to 0.065 in. on all grinding spindles. Thus, it is possible to use high feeds and speeds. Boring is done on a gun boring lathe, and boring the taper and finish turning and facing the flange is done on a turret lathe. The rough grinding operation leaves 0.005 in. for finish grinding.

Milling the slots in the flange is done on a Cincinnati horizontal miller. The fixture mounts the spindle lengthwise on the table, being located by two ground, cast-iron bushings that support the rough-ground bearing diameters. Interlocking cutters make possible the maintenance of accuracy, and vertical feed is employed.

Finish grinding is done in two opera-

Fig. 1—One product, spindles for milling machines and grinders, goes through this department. Such concentration of effort is necessary to meet required tolerances and to achieve reasonable costs

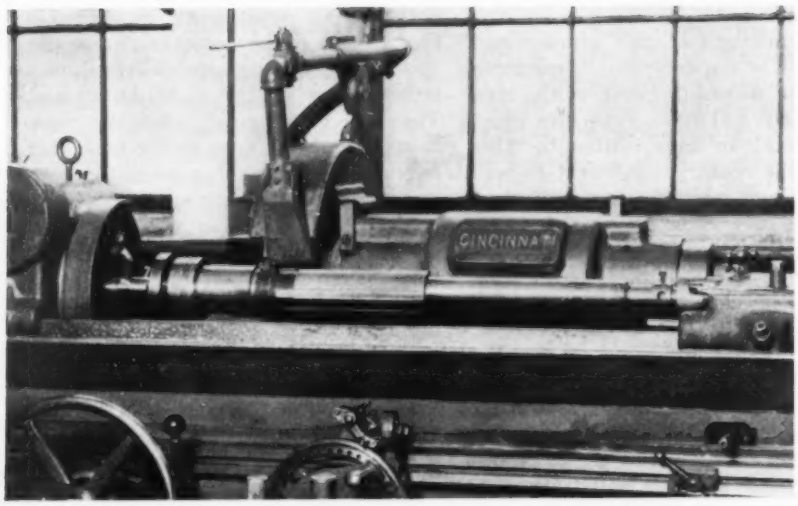


Fig. 2—Finish grinding is done in two steps. Rough grinding leaves 0.005 in. for semi-finish grinding to 0.0015 in. The final grinding is to tolerances of 0.0002 to 0.0005 in.

tions on the machine shown in Fig. 2. Tolerances range from 0.0002 to 0.0005 in. on principal dimensions. The first setting consists of semi-finish grinding all diameters to 0.0015 in. At this point the hole in the milling spindle is rough ground concentric with the bearing surfaces in a special Heald internal grinder. The spindle is then finish ground, the rough-ground hole being used to support a plug from which is obtained the center for external grinding. After finish grinding the spindle is put back into the special Heald grinder for finsh grinding of the hole and face of the flange.

Special Grinding Set-Up

The hole in the spindle must be concentric with the bearing surfaces, and the face of the flange must be at right angles to the axis. Accuracy in these respects is secured by locating from the finish-ground bearing surfaces. Finish grinding of the hole is done with the set-up shown in Fig. 3. The rear center of the spindle is carried by a live center. A sleeve is placed on the rear bearing and clamped to both the work and the headstock spindle. The front bearing of the spindle is carried in a bronze alloy bushing which is self-adjusting.

A separate operation is provided for grinding the slot. A sleeve with two master slots is placed on the front bearing of the spindle, which is then placed between centers in a loading fixture. After the sleeve is adjusted in relation to the spindle, the vertical head is fed down and a light cut is taken on the upper side of the slot. The spindle is indexed and another cut is taken on the other side. One-half of the remaining stock is then removed from each side by several passes. A dial indicator set-up determines the central location of the slot. The face of the flange is ground by using the same vertical head.

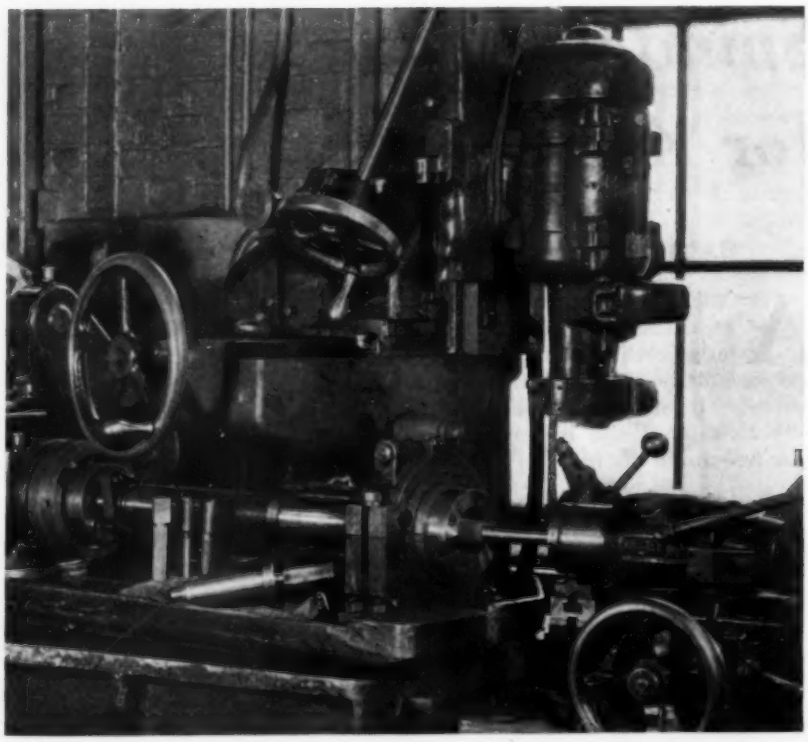


Fig. 3—Special Heald grinder for grinding the taper hole, the face of the flange and the slots. The vertical head does the last two operations

Control of quality is maintained through a program of frequent inspection. Before machine operations a complete chemical analysis is made of the steel, and a microscopic examination determines the structure and the presence of inclusions. The spindle is inspected for size before heat-treatment, each diameter being micrometered, lengths scaled and threads tested to fit the mating nuts. Finish is inspected by the aid of a lead lap to emphasize chatter marks. To check the concentricity of the hole with the outside diameters an accurate lining bar is fitted into the ground tapered hole while the spindle is mounted in V-blocks. A dial indicator shows the run-out in two positions; one at the nose and the other 18 in. from the nose. Run-out tolerance at 18 in. from the spindle nose is only 0.00075 in.

Economical Heat-Treatment

Continuous heat-treating operations afford economy and close control. Forgings are normalized in an electric furnace, Fig. 4, being under heat for 3½ hr. They are then transferred to the lower of two ovens for cooling. The following lot is preheated in the upper oven, utilizing the heat from the normalized lot in the oven below.

After the requisite machine operations, heat-treatment is accomplished in two "Hump" electric furnaces, Fig. 5. One, 48 in. deep, is used for most standard spindles, and the second, 64 in. deep, is used for the longest spindles, arbors and shafts. A small plug opening is provided in the furnace cover so that the spindles can be charged or removed without opening the large cover. Distortion is minimized because the

spindle is hung vertically and also quenched in this position. Two large quenching tanks, a heat interchanger, a return storage tank and a rapid circulating pump comprise the automatically controlled quenching system. By means of a thermostat the counterflow of water is controlled so that the ideal quenching temperature can be maintained without attention of the operator. After heat-treatment each spindle is tested for hardness over its full length in a Brinell hardness testing machine.

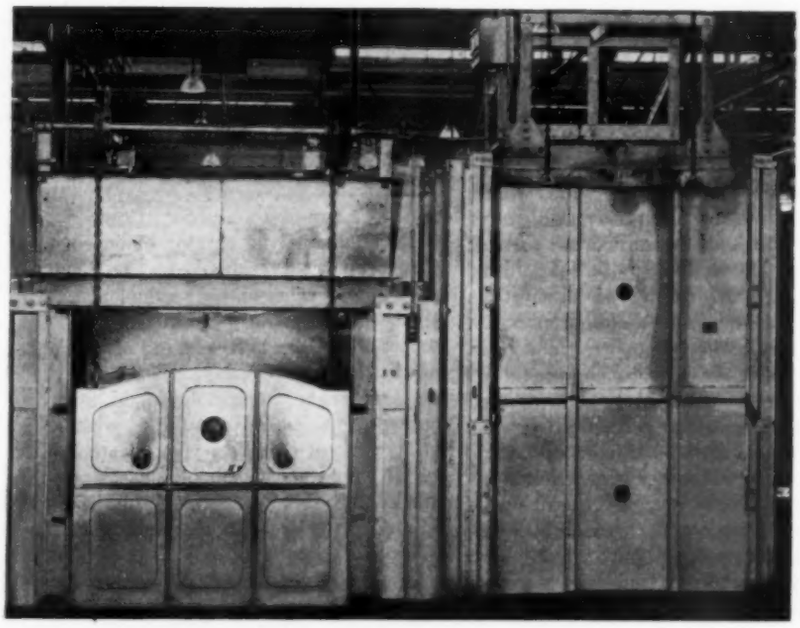


Fig. 4—Normalizing of forgings is done in the furnace at the left. The lower oven at the right receives the work for cooling, the heat given off preheating the incoming lot in the oven above

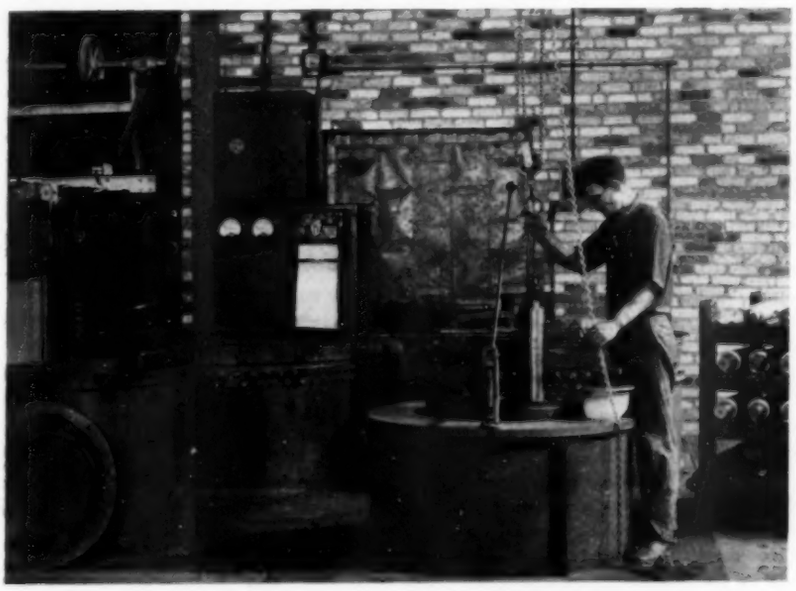


Fig. 5—Heat-treating of spindles is done in Hump furnaces to minimize distortion. Quenching media temperature is maintained automatically

Less Specialization?

FRANK C. HUDSON

Specialization became a slogan perhaps a quarter of a century ago. One ardent advocate of my acquaintance predicted that the time would come when one shop would make nothing but 24-in. pulleys while the shop next door made 26- or 28-in. pulleys, according to a standardized increment. He stuck to one size of machine until he had supplied the market and then had to branch out in other lines. There is no question as to the advantages of specialization when the output can be planned to supply the market, but we are still some distance short of that goal.

Specialization by operators of machines also has advantages—until you have another machine you want him to operate. Cylinder grinders, for example, were in great demand up to a few years ago. Then, almost over night, cylinder grinding gave way to honing and the cylinder grinder operator was out of luck.

Management frequently complains that men are not willing to change jobs. While true in many cases, there are reasons. One is that they have had no fundamental training on machines as a group but only on one type of machine, such as milling or grinding. They are more or less afraid of other machines and hesitate to tackle a new job. A little basic training will prevent this feeling. The other reason is that changing jobs usually means a thinner pay envelope during the preliminary work on the new job, and no one welcomes that, especially when rates have been cut and hours shortened.

Shops which are not too highly specialized stand the best chance of keeping busy and the same applies to the men who keep the shops going.

Old Tires Protect Castings

J. R. SHEPPARD
Chief Engineer, Lake Erie Engineering Corp.

We have recently found a new use for the discarded auto tire cut into proper lengths.

We use them in our machine shop for protecting slings and cables and finished surfaces on heavy castings. We also use them to protect both castings and floor, using them as cushions for turning heavy pieces over. This very simple idea has saved us many dollars in slings and cables and in protecting finished surfaces.

Press Tools for Valve Spring Guides—Discussion

M. P. DALTON
Sevenoaks, Kent, England

The method of making guides for valve springs described by John G. Jergens (*AM*—Vol. 77, page 827) follows regular practice and ignores the drop hammer and its possibilities.

I should blank and pierce the guides in one operation in the press, using compound tools. Then I would form the guides by a single bump under a 60-lb. drop hammer.

A Task for Old Timers

LUCIEN I. YEOMANS
Industrial Engineer

THIS is an open letter addressed to every man who is a manufacturer of machinery and who has incidentally accumulated a substantial fortune and who feels any inclination or obligation to assist in the perpetuation of the industry in which he is interested through a transference of skill and fundamental knowledge from the rapidly dwindling ranks of the older all-around mechanics to a younger generation.

Apprenticeship, except in a very few shops, has become a thing of the past. It has degenerated in most shops into a training period during which common labor is paid a relatively low wage and is trained in some special branch of skilled effort rather than in the broad practices of a trade.

The rate of pay of such so-called apprentices is comparatively high and they are usually able bodied men of family, or other responsibilities, rather than boys of impressionable age. What they learn of the fundamentals of a trade is very little and the condition is not properly designated as apprenticeship.

Finding Foremen

About a half century ago a large manufacturer of machinery complained to Mr. Richmond Viall that he was unable to find enough satisfactory foremen for his organization. Mr. Viall asked if he took apprentices, and, upon being told that he could not bother with them, told him very plainly that he did not deserve any better luck in securing foremen than he was having and that the Brown & Sharpe supply of foremen was largely drawn from their own former apprentices.

The canny manufacturer of that day not only trained the sons of other men, in his apprenticeship course, to become his highly skilled and reliable workmen and his future departmental executives, but he trained his own sons in the same way, either in his own shops or the shops of others, to become his own successors.

Today a manufacturer's sons are overschooled in preparation for college, are finally graduated from some engineering course, and then enter their father's business with nothing but a smattering of the fundamentals of the business, with little knowledge of the view point of working men whose labor conversion is to be their business, but with much experience in social arts and practices which the business does not really need —or could do without.

At the time and in the shops where aprentices were taken, the problem of finding something for skilled old men of the trade who had lost their speed or strength to do was not so difficult as now. There was not the high pressure grind of production that we know now. Plenty of things were to be done that the old, responsible heads were fitted for and that interfered with nothing else. Their hearts were not broken and their death hastened by being pensioned or superannuated as long as their health permitted their coming to the shop. Today we murder these faithful old men and they die before their time on account of our pensions and theoretically perfect welfare arrangements.

It would not be impracticable for any large shop to establish a department of old men and apprentices in which would be built desirable special machinery and equipment that is a nuisance in every shop when run through regular production departments. Such a department could well make complete testing equipment and devices, carry on all experimental and development work, repair and rebuild machine tools, and all like unusual activities. The wide range of operations and small lots of duplicate parts would keep the boys interested, the knowledge of the business and its requirements which the old timers possess would be a safeguard against many mistakes, and they would warn against duplicating the forgotten mistakes of many years ago.

Skill and Strong Backs

The old fellows would furnish the skill and the boys the strong backs and ambition, there would occur an automatic transference of skill and traditions, and old practices of value would be handed along, to the ultimate great advantage of the shop.

Perhaps the writer is becoming sensitive about his own age, as he is twenty years older than the age limit at which applicants are refused employment at the largest shop in Chicago, but it is a certainty that he is without any question a more informed, resourceful, and effective employee today, in any capacity for which he qualifies, than when he was twenty years younger.

Admitting that any large shop could carry out the plan outlined above, it seems improbable that it would be done in many places and an alternative plan is proposed in which a group of those men to whom this outline is first above addressed would join in the endowment of a training school-shop.

Such a school-shop could operate a six- or seven-hour period of shop work, daily, and still furnish the required preparatory school training for college entrance and leave any necessary time available for desirable recreation.

Reference to the catalog of one of the first preparatory schools in the country shows that the actual school days of the year, including examinations, total only 164. Our shop working schedule is always at least 300 days per year so that a three-year apprenticeship in such a school-shop would combine with the equivalent of over five years' time in the usual preparatory school, or the school work to be covered could be lessened in hours per week correspondingly.

Housing the Apprentices

There would be provided for such a school-shop no great dormitories. The housing facilities would consist of small but well built homes and these homes would be assigned to the old men and their families and each such family would take as roomers one or two or more boys. The boys would, however, get their meals at a general mess hall unless by special arrangement, as would those of the old men who were single.

Instructions for the school activities would be provided but the shop supervision would be almost negligible. Here one old man would be the mentor and supervisor of one or two boys, with whom he would work, and the minimum of other supervision would be necessary. The transference of skill would be by practical example, by stories of other work, by comparisons of different practice, and by the desire of each old man to make his boys outclass the others.

In this way a boy could finish a shop apprenticeship and his preparatory school simultaneously and whether he went to college or continued to work elsewhere he would be turned out of this school-shop at a college entrance age.

If he attended college afterward he would know what he was there for

and what he wanted to learn and would know its use. He would be credited with the college "shop work" as a matter of course and have more hours available for other study.

If he elected to go to work he would be a skilled man at an early age and as a mechanic would rapidly be recognized as an outstanding employee. By the time he reached the age at which his former classmates in the school-shop who elected to go to college were leaving there he would have four years additional shop experience and would be good foreman material.

Boys who went either way after leaving the school-shop would be valuable men for any employer. They would know the fundamentals of manufacturing at first hand and would have ideas of production that can be taught only in this way.

The manual training school, the college shop, and the half-time continuation school can never make good mechanics. Nothing can take the place of the daily shop grind and the largest whistle in the country should be the one at the school-shop.

Most shops that provide for pensioners would rather send them here and provide a small sum for their care than see them out of work and unhappy in their idleness.

Such a school-shop could build, at cost, devices and equipment for scientific purposes that would otherwise never be built and many developments and problems could be solved here that would otherwise remain unsolved.

Such a school-shop could be self supporting after an endowment for buildings, equipment, obsolescence, etc., was provided and it would make valuable old employees happy, give young men a chance that does not now exist, and furnish to industry an annual supply of well grounded embryo executives.

Sharpening Files

Sharpening dull files is an "economy" that bobs up periodically. Both the acid process and sandblasting were old when I was an apprentice—and that was soon after Noah landed his ark. On several later occasions I've run into this same idea, which is usually marked with enthusiasm, and then quietly disappears. Another method was to anneal, grind off all the teeth, recut and harden. It is probably cheaper, however, to buy new files. And now one of the largest makers of sandblast apparatus frankly tells a would-be customer that it will not pay. It looks as though the only way of keeping files in good condition was to buy plenty of new ones.

Checks on Gear Tooth Accuracy Discussion

ALLAN H. CANDEE

IN AN article under the above title (*AM*—Vol. 78, page 123) Ivor J. Gruenberg says: "It is next to impossible to determine the tooth thickness of a helical gear or worm with gear tooth calipers. Anyone familiar with helical gears or worms will agree that at best it is a poor approximation."

I wish to take exception to this statement. There are three principal factors upon which the accuracy of measurements with tooth calipers depends:

1. Calculation of correct caliper settings, based upon the known outside diameter of the gear;

2. Condition of the calipers used;

3. Handling of the calipers by the user.

There need be no question of approximation in (1), while (2) and (3) affect all measurements with vernier calipers. From actual experience, extending over a considerable number of years, I know that it is entirely possible to determine the tooth thickness of helical gears and worms with an error not exceeding plus or minus 0.001 in., that is, with about the same degree of accuracy as in any measurements with vernier calipers. Anyone with experience with both methods of measurement, however, knows that measurement with a micrometer and a pair of hardened and ground steel pins is more sensitive and more accurate.

Mr. Gruenberg recommends using pins of such diameter that they contact with the gear teeth at the ends of the so-called constant chord. This requires a different pin diameter for each different number of teeth, even of the same pitch. *American Machinist* has in past years printed tables for checking gear tooth thickness with pins of standard diameter, by the use of which it is only necessary to divide the tabulated values by the diametral pitch. Sam Trimbath (*AM*—Vol. 62, page 784) adopted a pin diameter equal to 1.750 in. ÷ D.P. I have contributed rather extensive tables (*AM*—Vol. 68, pages 365, 463 and 573) for both external and internal involute gears in which the pin diameter was 1.680 in. ÷ D.P. Both of these systems are in actual use in a number of shops.

Mr. Gruenberg rejects the use of pins of given diameter because the required calculations are too long. It seems probable that he is not acquainted with the standard systems which have been described. The cost of a set of standard pins is not great; but the expense of obtaining a pair of hardened steel pins ground accurately to a special diameter every time a gear with a different number of teeth is to be checked, to say nothing of the delay involved, would be prohibitive in most shops.

Equations 13 and 14, given by Mr. Gruenberg for the diameter of pin and the diameter at the outside of pins in helical gears, are very close approximations. The result obtained in a numerical example, assuming 21 teeth and a 30-deg. helix angle, checked satisfactorily with the method of calculation given by the writer (*AM*—Vol. 68, page 574). Equation 15, however, for the measurement over pins in a helical gear with odd number of teeth, takes no account of the effect of the helix angle. It becomes dangerously inaccurate when the angle goes much over 30 deg. Some numerical values will show what actually occurs.

N = number of teeth (odd)
D_c = diameter at center of pins
D_m = caliper dimension between centers of pins
α = helix angle
ΔD = correction for odd number of teeth

$$\Delta D = D_c - D_m = D_c\left(1 - \frac{D_m}{D_c}\right)$$

Assume: $N = 21$; $D_c = 5.000$

α	$\frac{D_m}{D_c}$	$1 - \frac{D_m}{D_c}$	D_c	ΔD	D_m
0°	0.99722	0.00278	5.000	0.014	4.986
15°	0.99699	0.00301	5.000	0.015	4.985
30°	0.99580	0.00420	5.000	0.021	4.979
45°	0.97514	0.02486	5.000	0.124	4.876

When the helix angle is zero, the ratio $\frac{D_m}{D_c}$ equals $\cos\frac{90°}{N}$ as given by Mr. Gruenberg; and for helix angles not exceeding 20 deg. the change is almost negligible. For large helix angles, however, it is apparent that a greater accuracy of calculation is required. The method of making this calculation will have to be left for a later time. Meanwhile, with a gear with an odd number of teeth, it is always possible to measure across one pin and the opposite tooth and thus avoid having to make the correction.

Balancing on a Production Basis

E. CHAT SHANKS

Cut-and-try methods are removed from static balancing by a device which mounts the work on a vertical axis

STATIC balancing has not kept pace with other mechanical developments of recent years. The cut-and-try methods employed have done more to deter the utilization of high speeds than any other factor. The "*X* marks spot" location of unbalance, combined with haphazard drilling or selection of weights, has been both costly and inaccurate. Even by repeated trials, the process of elimination has been far from satisfactory—tolerated only for lack of a better method.

The devices used in static balancing, though made with extreme accuracy, have remained crude in principle. All are dependent upon the tendency of the work to rotate and settle to the position in which the center of gravity is lowest. This tendency is opposed by inertia, friction and mechanical sluggishness which defeat theoretical accuracy. The location is indefinite and the amount of unbalance undeterminable within any desirable degree of accuracy.

An entirely different mechanical situation is created when the rotative axis is changed from a horizontal to a vertical position. Although the operation depends upon lowering the center of gravity, rotation about a center is altered to the simple movement of a beam on its fulcrum. If the fulcrum of the work is made to coincide with that of a weighing beam, the amount of unbalance can be readily determined. This principle permits further refinements to locate the exact axial plane of unbalance and mechanically to calculate the correction to one one-hundredth of an inch-ounce.

Fig. 1 illustrates a simplified device cross-sectioned in an assumed axial plane of unbalance. Support *A* has a fulcrum upon which beam *B* is balanced without weight *C*. The arbor portion of *B* supports work *D* on which the heavy spot *E* is to be balanced by hole *F*. Spot *E* causes beam *B* to tip on fulcrum *A*, but adjusting weight *C* along beam *B* restores the balanced condition of the unit and indicates the amount of unbalance at *E* to be corrected at *F* statically to balance part *D*.

Next assuming, in Fig. 2, that fulcrum *A* is a cone, it is obvious that the axial plane of unbalance can be in any angular direction. Beam *B*, by tilting in the direction of heavy spot *E*, shows its angular location. Then placing weight *C* in the plane indicates the correction as before. Conversely, if weight *C* is in a fixed plane, as shown by the dotted lines, the tilt of beam *B* will indicate the angular deviation of the plane of unbalance. Then part *D* can be rotated upon arbor *B* until the plane of unbalance and the plane of the weight coincide; i.e., *E* and *C* are on opposite sides of *A*.

Referring again to Fig. 1, *G* is the center-line of the combined mass of *B* and *D* in a transverse plane, *H* is the center-line of the fulcrum or pivot. If *H* is below *G*, the beam will tip and remain in any angular position, regard-

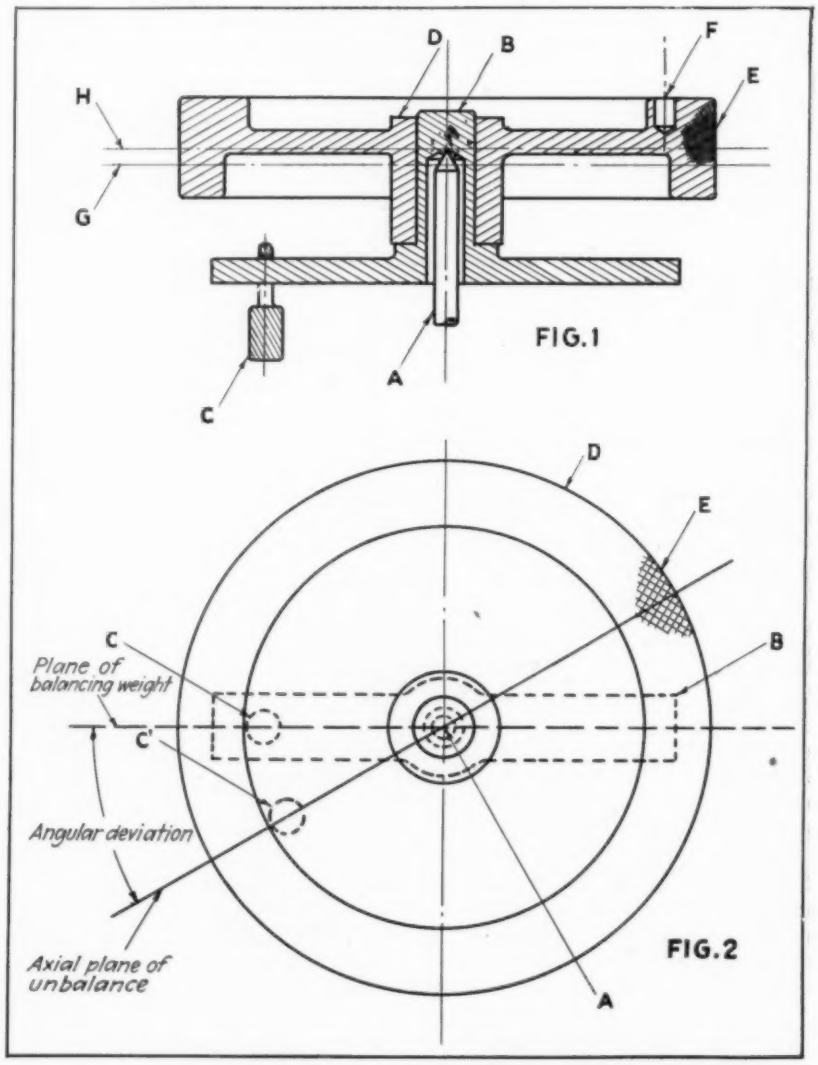
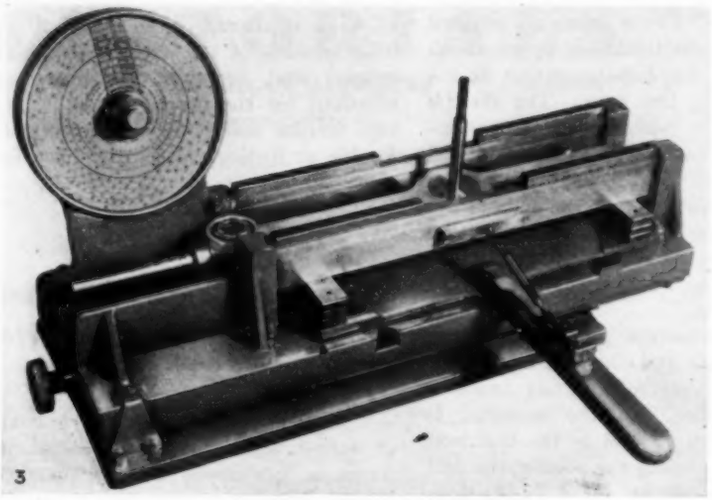


Fig. 1—A diagrammatic view of a beam and fulcrum illustrates the principle of the balancing device. Fig. 2—Pivoting the workpiece with reference to the beam establishes the angular location of unbalance



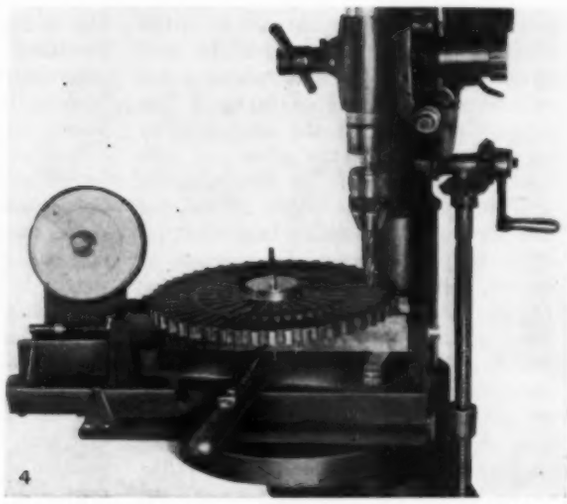


Fig. 3—In the finished machine the beam is graduated and a circular scale for mechanical calculations is provided. Fig. 4—The balancing device is mounted on a drill press, its mechanism locked when compensating holes are drilled

less of the axial plane of unbalance, because the center of gravity is lowered by tipping in any direction, and the tendency is greater as the unbalance is decreased or the distance is increased.

On the other hand, if *H* is considerably above *G*, the spot *E* will have an increased influence but sluggish action will result. It follows that the ideal location of *H* is slightly above *G* for the most sensitive balancing.

The location of the center of mass *G* depends upon the weight and width of *D*. Increases in the width or weight raise *G* and decreases lower it. Slight changes in weight come within the distance between *G* and *H*, but either *D* or *A* must be adjustable with relation to each other to accommodate different work embodying changes in size.

The weight of *C* and its distance from the axis of rotation being known, the magnitude of *E* need not be known, for they are in balance and therefore equal. Then, if the distance from the axis to the center of compensation *F* is known, the amount of compensation is easily determined. Further, if the radial distance to *F* is traversed by a mechanical movement, suitable scales properly connected to the movement can be made to show automatically the required amount of compensation.

From these principles of vertical axis balancing it is seen that the process differs radically from previous methods. In horizontal balancing, the process is principally dependent upon the judgment of the operator; in vertical balancing automatic calculations can remove the guesswork. The sluggish uncertainty of rotative movement is replaced with extreme sensitivity which is influenced by minute degrees of unbalance. Instead of a series of approximations which may, or may not, eventually produce a satisfactory balance, certain definite results are obtainable in a single trial.

In transferring the theoretical principles to a practical machine, inherent accuracy need not be sacrificed. The cone fulcrum in Fig. 1 is replaced by a more substantial means without sacrificing the essential sensitivity. The use of suitable work rests permits a lightness of the oscillatory parts, exerting a minimum counteraction to the part being balanced.

Fig. 3 illustrates a machine for the purpose. The base supports a carriage, movable longitudinally by a screw and handwheel, on which is mounted a cam supporting the work rest. The fulcrum is mounted in the carriage and projects upward inside the arbor which is a part of the weighing beam. The vertical position of the arbor and beam relative to the fulcrum is adjustable by means of a screw projecting from the arbor. The left end of the beam is graduated for the collar weight and has a universal level indicating tilt in any direction. Circular scales for mechanical calculations are geared to the carriage screw.

Parallel shims above and below the work rest keep the fulcrum adjustment within range of the screw and permit the cam release of the weighing beam from both the work and the fulcrum. The release is used when drilling, or otherwise compensating, for unbalance and when placing or removing work to prevent injury to the fulcrum and beam parts. A lock for the beam secures it against movement during these operations.

The universal level is of the spirit bubble type but is circular instead of cylindrical, allowing the bubble to move in any angular direction. The center, or level, position is marked by a circle on the glass. Two hair-lines, tangent to the circle and parallel to the center-line of the beam, show when the angularity is in the same vertical plane as the center-line of the beam, or equal to zero degrees.

The handwheel is used to offset the arbor radially from the drilling center. The zero adjustment is indicated by a longitudinal movement pointer and coincides with the zero reading on the circular scales. With the balancing weight set at zero, these comprise the starting point of the set-up.

The Drill Press Set-Up

The balancing machine is placed on the table of a suitable drill press and the locked arbor located directly under, and concentric with, the drill spindle. Arbor bushings and rest shims are selected to fit the work and are mounted on the machine. The beam and arbor are unlocked after the work is placed on the arbor and, raised to balancing position, will incline in the direction of the axial plane of unbalance, indicating the heavy side of the work.

The angle of the unbalance with the center-line of the beam is shown by the level bubble. The work is next rotated by hand until the bubble rests between the hair-lines on the level glass, showing that the axial plane of unbalance contains the center-line of the weighing beam. This places the weighing beam in line with the heavy portion of the work with the measuring weight on the opposite side of the fulcrum. The measuring weight is adjusted along the beam to equal the unbalance until the bubble rests in the center of the scribed circle in the center of the level glass, indicating that the beam and work are counterpoised.

The compensating holes are placed at

any convenient radial distance from the arbor to conform to the work, the only requirement being a spot where metal can be removed without injury. The carriage is moved by the handwheel to secure the offset of the arbor and drill spindle to the radius of compensation selected, placing the point of removal directly under the drill.

At the same time the carriage is moved, corresponding adjustment is imparted to the circular scales so that they conform to the compensation radius selected. The location of the measuring weight is read, the pointer on the dial set to the figure, a drill size selected and the exact depth of the compensation hole is read in thousandths of an inch. This reading includes the drill point so, with the point of the drill touching the work, a special dial indicator on the spindle housing is set at zero and the hole drilled to the required depth.

Drilling is Checked

The operation is back-checked by returning the weight on the beam to zero and releasing the beam lock. Except in case of an error, the bubble will remain in the central circle on the universal level.

On relatively thin work which is badly out of balance, or work in which deep holes must not be drilled, it may be necessary to drill several holes. In this event the calculating scales give the depth for each of the required number of holes. The location of the extra holes is made equidistant from the axial plane of unbalance with a pair of dividers. This operation must not be confused with the eliminative drilling of horizontal axis balancing. When more than one hole is needed in vertical axis balancing they are all drilled to the same depth at one time.

Compensation by adding weight is accomplished in the same way except the circular scales are used for ounces to be added instead of the drilling depth. Compensation by milling is similar and the chips are weighed as removed until they equal the reading on the scales. When all balancing is done by milling special scales can indicate the length of cut.

The range of work is provided for by multiple circular scales on the dial. It is possible to balance materials varying from cork to platinum by this method. Any diameter of work is adaptable to vertical balancing except long parts of small diameter, such as shafting. Different drill sizes are accommodated by the scales and the range, ⅛ to 1½ inches, is governed by the size of the work to be balanced.

As an example, consider the turbine disk in Fig. 4. Lower shims are selected according to the thickness, upper shims according to the hub projection and a bushing to fit the bore. The disk is placed on the bushing, the beam unlocked and the fulcrum screw adjusted to the point of greatest sensitivity. The disk is rotated to bring the bubble between the hair-lines with the heavy side opposite the balancing weight. The weight is adjusted to bring the bubble into the circle.

The compensation radius is selected at 5.65 inches and the carriage offset. The reading on the weighing beam is 0.95 inch-ounce and the material is cast iron. Setting 0.95 to the cast iron location and placing the pointer, the drill depths are 0.203 in. for a ⅞-in. drill, 0.283 in. for a ½-in. drill, or 0.859 in. for a ¼-in. drill. Selecting the ½-in. size, to avoid drilling through, the point is placed against the work, after locking the weighing beam and raising the work rest, and the spindle indicator set at zero. The hole is drilled 0.283 in. deep, the drill removed, the balance weight returned to zero, the beam unlocked and raised to the balancing position. The turbine disk is found to be in balance by the bubble remaining within the circle.

Following pieces go through a similar procedure, except that no setting-up or longitudinal movement of the carriage is necessary. Actual time studies have shown a production of better than one per minute on medium sized parts.

The accuracy of the work is due to the special level and the adjustable fulcrum which it is possible to use with vertical axis balancing. The spirit level must be ground accurately to an arc of 2 min. per 1/10-in. movement of the bubble so that the slightest deviation of angularity or inclination is discernible. The fulcrum must be located about 1/32-in. above the center of mass to produce the most sensitive condition.

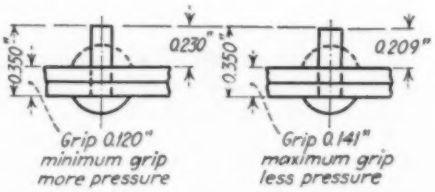
The high production of this method of static balancing is the result of definite location of the axial plane of unbalance and accurate mechanical calculations for the compensation. These two factors make retrials unnecessary, for the correction will be right the first time.

Pressures Required to Head Small Duralumin Rivets

GEORGE A. FRIES

The accompanying table is a record of actual tests in heading duralumin rivets in fabricating aircraft members. The pressures given are the average of three readings from a testing machine of 10,000 lb. capacity.

While these readings were taken from actual tests, the pressures required will vary slightly under certain conditions. For instance: The greater the gripping length of the rivet (the gripping length being the combined thicknesses of the parts to be riveted together) the less will be the pressure required to head the rivet, as shown by the illustration. This is because the greater the gripping length the less the rivet will protrude, consequently there will be less metal to be compressed. Then, too, if the rivet is not in direct line with the plunger it will bend slightly and will require less pressure.



Effect of minimum and maximum gripping lengths on pressure required to head duralumin rivets

Average Pressure Required to Head Duralumin Rivets

Rivet Size	Condition of Rivet	Thickness of Sheets	Condition of Sheets	Average Pressure in Pounds	Number of Tests
1/16	Annealed	1/16	Ht-treated	870	3
1/16	Ht-treated	"	"	920	"
3/32	Annealed	"	"	1,350	"
3/32	Ht-treated	"	"	1,725	"
1/8	Annealed	"	"	2,730	"
1/8	Ht-treated	"	"	2,890	"
1/12	Annealed	"	"	3,030	"
1/12	Ht-treated	"	"	3,130	"
3/16	Annealed	"	"	3,710	"
3/16	Ht-treated	"	"	4,490	"

Heat-treated rivets were headed 30 min. after heat-treatment.
Two thicknesses of sheets were used to give a grip of ⅛ in.

EDITORIALS

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K. H. CONDIT F. H. COLVIN

EDITORS

Fred Geier

A VITAL FORCE has gone out of the metal-working industry. With the passing of Fred Geier those who knew him best have lost a tried and true friend; those who worked for him have lost an employer whose thoughtfulness for his employees was outstanding; those who were associated with him in civic, industrial or business affairs have lost a wise councillor and a progressive, wide-visioned leader.

Few men of our time have left evidences of work more impressive or more enduring than those for which Fred Geier will be remembered. His own company, The Cincinnati Milling Machine Company and Cincinnati Grinders Incorporated, the Oakley Colony of machine-tool building companies, and the other companies and banks of which he was a director or officer are monuments to his business genius. His leadership in Community Chest campaigns, his presidency of the Ohio Mechanics' Institute, and his untiring efforts for the Children's Home are proofs of his interest in and contributions to civic and educational welfare. His participation in the affairs of the trade associations of his industry, as an officer and as a member company representative will not be forgotten.

Fred Geier will be hard to replace.

A Golden Opportunity

THERE are indications that the Wagner Bill will not pass at this session of Congress or, if it does, that it will be so modified as to permit plant organizations of the works council type. Such organizations have been mutually beneficial in a number of instances and they offer the best means of collective bargaining yet devised. It is time for management to meet the situation fairly and frankly. Company dominated unions have been ruled out. The choice lies between a really cooperative organization that can and will handle problems as they arise in the plant, or a craft or a vertical union that is part of the American Federation of Labor or other national organization.

Works councils have advantages over craft unions both for men and for management. Plant conditions affect all the trades involved and can be treated more effectively by a plant unit than by any one of the crafts. But if works councils are used solely to counteract American Federation of Labor activities they are not likely to succeed. They must be organized with an earnest endeavor to promote harmony and justice in all phases of plant relationships. Cooperation must be the keynote, and arbitration by men acceptable to both parties must replace strike and lockout as a court of last resort.

There are a number of works councils having enviable records, even in these trying times. These should be carefully studied by responsible management executives. It is too vital a subject to be left to subordinates when such a golden opportunity to lay a foundation for harmonious relations in the future presents itself.

Changes in Management

ONE OF the indications of the changing attitude of management is the study being given to the handling of materials, largely on account of its effect on the men. Instead of having men lift heavy castings, with the possibility of rupture, mechanical hoists are being installed for work of even moderate weight. It is found that not only fatigue, but the mental attitude, is affected by providing modern handling facilities.

Another noticeable feature is the use of short conveyors, in connection with hoists, small jib cranes or other apparatus, instead of long and elaborate conveyor systems which were not flexible to suit changing conditions. In fact, even in large production plants, much more attention is being paid to flexibility in both equipment and layout.

Then, too, the modern production plan is so arranging machines and operations that an operator can handle the work without undue speed or exertion. The old days of speeding-up and hustle seem to be on the wane.

Where Costs Belong

PRODUCTION men are playing a more important part in manufacturing establishments than ever before. Formerly it was their job to take anything emanating from the engineering department and make it. No matter how difficult the part or how much it might be simplified, their job was to make it without question. "Theirs not to question why, theirs but to do and die," much in the manner of Tennyson.

But it's a different story today. Now the engineering department consults production and frequently changes designs to secure lower machining costs. Pro-

duction is also consulted before setting tolerances, or should be, not to jeopardize satisfactory performance where close tolerances are necessary, but to counteract the tendency of designers to play safe by demanding close tolerances whether needed or not.

This change of attitude has been brought about largely by the refusal of the production men to be blamed for excessive costs when the fault lay in the design. They now have another job to do in insisting on a revision of archaic methods of accounting which charge production with many items of overhead that belong elsewhere. Costs due to changes of design after a part has been put in production do not belong to production but to engineering. If these changes are made at the insistence of the sales department that is where the costs belong.

The production man has worries enough without shouldering those that belong elsewhere.

.CHIPS.

Washington—President Roosevelt settles automobile strike, vetoes Independent Offices Appropriation Bill, signs Vinson Bill authorizing Treaty Navy, arranges to have private air transport companies submit temporary air mail bids—and goes fishing . . . Congress overrides veto in first major defeat for President . . . Decides to investigate Dr. Wirt's charges that Brain Trust is plotting revolution, but without too much conviction . . . Plans early adjournment in order to encourage continuation of business revival, and look after political fences . . . General Johnson favors permitting NIRA license provision to lapse rather than risk general revision . . . House passes bill prohibiting loans to countries that have not arranged to pay debts to U. S. . . . Peek outlines plan for world trade "by cutting holes through the tariff wall" . . . Power lobby disclosures at Albany hearten "control everything" school of legislation.

Foreign—Nazis embargo copper imports, double military appropriation . . . Cunard resumes work on super liner after two-year delay . . . Great Britain to start industrial regulation corresponding to NRA by fixing wages in the textile industry . . . Pope encourages young Catholics in Germany to resist "paganization" by Nazis . . . Soviets sign non-aggression pacts with Esthonia, Latvia and Lithuania.

Finance—Senator Glass introduces substitute measure authorizing Federal Reserve Banks to make direct loans up to five years for industrial working capital in place of regional banks and R.F.C. . . . Jones reports that private banks are extending more commercial loans and that the calls on R.F.C. are diminishing . . . Treasury offers 3¼ per cent, 12-year bonds to holders of $1,005,000,000 of called 4¼ per cent Liberty bonds . . . Extends same privilege to holders of 3 per cent notes due May 2 . . . Move encourages bond market operators . . . Passing of exchange control legislation becomes doubtful.

Industry—Steel companies raise wages 10 per cent . . . Mullins Mfg. Co. does likewise . . . 3,000 strike for higher pay at New York Shipbuilding Co.'s Camden plant . . . Johnson appoints Industrial Relations Committee of six to settle the strike . . . Hupp reopens Cleveland plant to build bodies . . . Soft coal miners get shorter hours and higher wages . . . Packard about to announce a low-priced car . . . Great Western R.R. gets $1,200,000 for new box cars . . . Budd strike settlement includes compromise as company agrees to take back one striker for every new man hired . . . 700 machinists in eight Akron tool shops strike for union recognition and a 10 per cent increase . . . General Electric announces 10 per cent increase in hourly rates and salaries under $2,600 . . . N. Y. Central buys 38,900 tons of rails . . . General Johnson modifies automobile parts code to permit overtime to be averaged over the year . . . Sloan says, in General Motors report, that recovery has gained an impetus that cannot be stopped by Washington action . . . Taylor tells U. S. Steel stockholders that revival is well under way . . . Willys-Overland plans to keep 3,000 busy during the summer . . . Automobile labor board takes over Nash strikes for settlement . . . H. H. Franklin automobile company files voluntary bankruptcy petition . . . Big brass companies raise wages 10 per cent . . . Detroit toolmakers demand 20 per cent increase and 36 hours.

Trade—Cabinet committee made up of Secretaries of Commerce, Agriculture and Labor, and the Attorney-General to study open price policies . . . NRA Distribution and Consumer Service Trades Committee defends open prices . . . Sears-Roebuck reports 57 per cent increase of sales in March over March, 1933 . . . Prices raised on all Chrysler and General Motors lines and on two Studebaker models . . . Ford stands pat . . . Second quarter carloadings will show better than 10 per cent increase over last year . . . Prices of finished and semi-finished steel raised $3 to $8 a ton . . . Increased buying of steel scrap presages upswing in mill production . . . Copper price rises to high for year in anticipation of code approval.

Indicators—Steel production turns upward again . . . Electrical energy output continues to climb . . . Carloadings recede slightly . . . *Business Week* index rises a bit to 65.2 . . . March steel output triples that of a year ago.

"Board of Three" Plan Extended to Other Industries

A general order by NRA, extended to all codified industries, the "board of three" plan set up for resolving labor disputes in the automobile industry. Some time ago it was provided that labor problems in an industry might not be handled by the code authority unless such a board, made up of one representative of labor, one of the industry, and a neutral member had been set up. Several codes already have such boards.

While not a direct blow at the National Labor Board or at the Wagner Labor Disputes Bill now having a stormy time in a Senate committee, the new order will unquestionably tend to lessen the importance of both. The National Labor Board was set up solely to handle cases where stoppage of work is imminent or has taken place, but actually its regional labor boards have been functioning in disputes in the field.

The automobile controversy first went to Washington to be heard by the National Labor Board, but was taken over by General Johnson as the President's mediator. The fact that William Green, president of the A. F. of L., whose organizers in Detroit were the complainants in the case, sat as one of the judges of the National Labor Board, probably had considerable to do with the shifting of the center of responsibility.

While undergoing considerable revision, it is an open question whether the Wagner bill will ever pass Congress. Senator Wagner himself has conceded that the bill should not outlaw all company unions, but only the "company-dominated" ones. He has also given in on the provision that decisions of fact by the board shall not be subject to review by the courts. However, if materially changed the bill may lose the active support of A. F. of L. leaders. Senator Wagner is of the belief that the bill can be modified without harming its definite plan to eliminate the company-dominated union and give the workers greater power in bargaining.

Dr. Wolman Appointed to Auto Board

In accordance with the principles of settlement, announced by President Roosevelt, which averted a strike in the automobile industry, a board of three has been established to pass on all labor questions. Members of this board have been announced as Dr. Leo Wolman, chairman of the NRA Labor Advisory Board, neutral representative; Nicholas Kelly, Chrysler Motor Car Corporation, industry representative, and Richard Byrd, labor leader of Pontiac, Mich., labor representative. The board's first ruling prohibits proselyting for members during working hours by either company or outside unions.

L. P. Alford Appointed to Code Authority

According to a recent announcement by Administrator Hugh S. Johnson, L. P. Alford, former editor of *American Machinist*, has been appointed administration member of the laundry and dry cleaning machinery manufacturing industry code authority. Mr. Alford has been associated with the McKay Shoe Machinery Co., and the United Shoe Machinery Co., and is now vice-president of the Ronald Press Co., and a partner in G. Charter Harrison Associates. Other recent administration appointees to code authorities in the metal-working industry are as follows:

Anti-friction bearings—R. L. Ahearn;

Horseshoe and allied products—William D. Ward;

Automobile manufacturing—Frederick J. Haynes, succeeding Karl J. Ammerman. Mr. Haynes was formerly general superintendent of the Lake Shore Engineering Works, factory manager for the H. H. Franklin Automobile Co.; factory manager for Dodge Bros.; president of Dodge Brothers; president of Durant Motor Co.; vice-president and director of the Franklin Automobile Co.; and for several terms director of the National Automobile Chamber of Commerce.

Railway car appliances—Elmer M. Naylor, vice-president of the Naylor Pipe Co.

Automotive parts and equipment manufacturing—Ralph H. Gage, secretary and director of the Gage Structural Steel Co., succeeding K. J. Ammerman;

Printing equipment and newspaper printing press—Colonel H. K. Rutherford;

Vacuum cleaner manufacturing industry—Prof. H. B. Dates, head of the electrical engineering department, Case School of Applied Science;

Textile print roller engraving—R. L. Ahearn, formerly vice-president of the Western Waterproofing Co.

Metal lath manufacturing—James L. Palmer, professor of marketing, University of Chicago.

Construction machinery distributing Trade—W. W. Tangemann. Hack saw blade manufacturing—Isham Keith.

Machine-allied staple and stapling machine industry—Willard D. Ward, consulting engineer.

Regulations Issued for Labor Elections

The recent announcement by Senator Robert F. Wagner, chairman of the National Labor Board, specifies that a board election can be invoked only where there is a real conflict over the desires of a petitioning group which are denied by an employer or by another group of employees. The regulation states in part that an election "is not the exclusive method for making such determination and need not be employed except in those cases where no other adequate method exists. Where, therefore, no controversy exists between or among any groups or factions of employees as to which group represents the majority or where it is conceded by all concerned that a particular group represents the majority of the employees, an election need not be ordered by the board despite the fact that a substantial number of employees may request it."

Capital Goods Revival C. of C. Meeting Topic

Included in the round table conferences, incident to the 22nd annual meeting of the Chamber of Commerce of the United States at Washington, D. C., from May 1 to 4, is a session "Progress and Problems in the Capital Goods Industries." William H. Meese, vice-president, Western Electric Company, will preside.

The meeting will be addressed by Malcolm Muir, president, McGraw-Hill Publishing Co., who will speak on "Conditions Necessary to Attract Investment to Capital Improvements"; Ralph E. Flanders, president, Jones and Lamson Machine Co., on "Rehabilitation of Industrial Plants"; N. F. Helmers, president, Associated General Contractors of America, on "Revival of the Construction Industries and the Direction It Will Take"; Stephen F. Voorhees, chairman, Construction Code Authority, on "Construction Industry Code."

Fred A. Geier Succumbs to Heart Attack

Fred A. Geier, president of the Cincinnati Milling Machine Co., industrialist and philanthropist, died suddenly at his home in Cincinnati on March 27.

Mr. Geier was known internationally as a leader in the machine tool industry and in Cincinnati as a worker for social justice. His development of employee relationships was far in advance of general industrial practice and reflected a liberal, forward-looking viewpoint. He exercised a wide scope of leadership in industry, civic, educational and social affairs.

Born and educated in Cincinnati, Mr. Geier entered the employ of the Cincinnati Screw and Tap Co. shortly after his graduation from Woodward High School. In 1889 this concern became the Cincinnati Milling Machine Co. He was one of the first men in this country to export machine tools, and before his death saw the products of his concern in use in about every country in the world.

Mr. Geier was a moving spirit in organizing the factory colony at Oakley where the beginning of the present plant was erected in 1909. In 1921, the milling machine company took over the Cincinnati Grinding Machine Co. This led to the development of the centerless grinding machine which is now made by an associated company, Cincinnati Grinders, Inc., of which Mr. Geier was also president.

Mr. Geier was one of the organizers of the National Metal Trades Association in 1901. In 1910 and 1911 he served as president of the National Machine Tool Builders' Association. Last year he helped to organize the Machinery and Allied Products Institute formed to include machinery groups operating under NRA codes.

Mr. Geier was also president of the Modern Foundry Co., the Factory Power Co., the Cincinnati Rubber Manufacturing Co. and the Cincinnati Morris Plan Bank. He was a director of the Cincinnati-Bickford Tool Co., the Century Machine Co. and many other concerns.

From 1913 to 1915 Mr. Geier was chairman of the Council of Social Agencies, from 1915-1917, chairman of the central budget committee, and from 1917 until his death, a member of the executive committee of the Community Chest. He was also chairman of the board of directors of the Children's Home.

FRED A. GEIER

Exports of Machinery During February, 1934

	Feb. 1934	Jan. 1934	Feb. 1933
Electrical machinery and apparatus	$4,295,618	$4,531,567	$2,461,271
Power generating machinery (except automotive and electric)	365,395	422,161	230,988
Construction and conveying machinery	407,661	322,713	237,176
Mining, well, and pumping machinery	1,393,850	1,301,506	882,606
Power-driven metal-working machinery	1,705,183	1,188,715	750,210
Other metal-working machinery	131,965	125,802	100,572
Textile machinery	704,855	637,524	281,888

Exports of Metal-Working Machinery During February, 1934

	Feb. 1934	Jan. 1934	Feb. 1933
Engine lathes	$110,341	$84,754	$88,101
Turret lathes	66,376	17,105	22,813
Other lathes	52,997	19,091	9,693
Vertical boring mills and chucking machines	48,493	23,638	24,165
Thread-cutting and automatic screw machines	57,791	56,760	30,101
Knee and column type milling machines	40,198	19,095	33,610
Other milling machines	142,016	76,981	13,768
Gear cutting machines	186,916	55,134	19,046
Vertical drilling machines	25,222	25,426	9,184
Radial drilling machines	35,516	4,374	.....
Other drilling machines	65,524	30,879	6,065
Planers and shapers	5,383	15,707	2,242
Surface grinding machines	55,075	32,946	24,123
External grinding machines	102,238	98,849	64,701
Internal grinding machines	128,724	81,807	29,106
Tool grinding, cutter grinding, and universal grinding machines	71,094	57,618	24,213
Other metal-working machines	55,610	86,258	28,737
Sheet and plate metal-working machines	153,723	106,617	83,762
Forging machinery	45,118	66,385	9,041
Rolling mill machinery	17,538	56,281	1,255
Foundry and molding equipment	31,098	17,308	51,135
Other power-driven metal-working machinery and parts	208,192	155,702	175,349

Other Metal-Working Machinery

Pneumatic portable tools	40,895	26,757	14,772
Other portable and hand or foot operated metal-working machines and parts	32,060	46,765	32,106
Chucks for machine tools	5,904	3,724	2,646
Machine operated pipe and thread cutters, stocks, dies, taps and other machine-operated tools	30,874	31,647	33,192
Other metal-working machine tools	22,232	16,909	17,856

Cost Standard Tried by Washing Machine Makers

Approval has been granted for a 90-day trial of the standard principles of cost accounting submitted by the washing and ironing machine manufacturing industry, under its code approved November 4, 1933. The trial began April 10, and at its conclusion, the costing system will become permanent unless otherwise ordered.

General Johnson approved the system with the proviso that "any member of the industry shall be permitted to sell below his individual costs to meet existing competition on products of equivalent design, character, quality or specification."

Patent Office Now Shows a Profit

A deficit of $150,000 in 1932 in the United States Patent Office has been changed by the flood of new inventions of Americans with "new leisure" to a profit of $400,000. The Patent Office will put on more employees and revise its entire classification to subdivide inventions and to make searches less difficult.

Secretary Roper Predicts Capital Goods Demand

"There is a large potential demand for capital goods," said Secretary of Commerce Roper recently, "and it will not take much to start it." He cited a survey of machinery needs made in Philadelphia by the American Society of Mechanical Engineers and the McGraw-Hill Publishing Co. and the local buying movement which followed. He said that such campaigns for modernization in other industrial centers would turn the trick and frankly admitted that capital investment market should be stimulated to this end.

Independent Union Wins in G. E. Vote

A recent announcement by the National Labor Board made public the results of elections held at the West Lynn plant and the River Plant of the General Electric Co. In both plants the Electrical Industry Employees Union, a recently formed independent group, won a plurality of the votes with the employees' plan of representation second, and the American Federation of Labor third. P. A. Donoghue acted as the board's representative in supervising the elections in conjunction with the New England regional labor board.

General Johnson to Direct Capital Goods Program

WASHINGTON—General Hugh S. Johnson, NRA administrator, will be given the job of directing the campaign for the revival of the capital goods industries which the National Emergency Council has determined is the key of the next step of the recovery program. The "Rebuild America" campaign will include the encouragement of home rebuilding and modernization for which $1,500,000,000 of the two billion dollars of public works money in the budget is to be earmarked, the survey of the "production capacity of industry" which is already under way with all industry divided according to functional capacity and with a view to finding how much it can do in the way of replacing obsolescent machinery, the study of financing of industry for its new equipment and working capital needs, and other plans which are now in an embryo stage but which are expected to be the key to the recovery program from now on.

This will be turned over to the NRA administrator when the full program is complete, and not before, for it is a clear-cut job which NRA will take on because it has the organization and is able to reach every element of business directly and effectively. General Johnson, discussing the issue, said this week that when the "very complete plan" is worked out, NRA will be happy to take it over. He reiterated his faith in this phase of the recovery plan, said that he had advocated it from the beginning, that it was part of his "original chart," and that NRA was deeply in sympathy with it.

"We cannot get any real recovery," the General said, "until we actuate the capital goods industries. This has been plotted from the first in our plans at NRA. The durable goods trade has been actuated partially by overlapping and influence from other developments, but as we look back on past booms, we know that they have been backed by such things as the automobile expansion and the building drive of 1928 and that when both of them busted at once we had many troubles. But properly controlled they can and will do a tremendous job. The consumer goods industries, we know, have gone as far as they could, without the support of the durable goods industries. Our concentration on them has been long forecasted and is now a definite policy."

Increases in Implement Exports Continue

Exports of agricultural implements in February registered a gain of 19 per cent over January and 65 per cent over February, 1933. The value for the month was $1,310,738 compared with $1,102,952 in January and $795,737 in February of last year.

About 52 per cent of the February implement exports consisted of tractors and tractor parts, with the outstanding gain made in track-laying tractors. The total value of this group showed an increase of 94 per cent over the corresponding month of 1933. Sales abroad of wheel tractors amounted to 283 units valued at $166,089, compared to 143, valued at $135,490 last year. Track-laying tractors totaled 123, valued at $240,393, compared with 34 valued at $66,227 in 1933. Tractor parts were exported to the value of $278,808 as compared to $151,367 a year ago. Large gains were also made in the tillage machinery group, February exports at $229,388, contrasted with $144,115 in February, 1933.

• INDUSTRIAL REVIEW •

• With one or two exceptions leading industrial centers report a slowing up of activity in machinery sales during the first week of April. Responsible men in the machinery industry attribute the slackening to the threat of the Wagner Bill and the epidemic of strikes that is sweeping the country. Generally speaking, inquiries are good and distributors have plenty of prospects which should lead to orders later when industry settles down.

• Strikes in Hartford and in the Philadelphia district have disturbed business in the eastern territory. Dealers are hopeful that orders will be released as the strikes are settled. Inquiries are holding up fairly well in Pittsburgh and orders for single machines continue to come in. No immediate labor trouble is reported. Local strikes are keeping the Cleveland labor situation in a very delicate condition. Otherwise business is still improving slowly. Distributors feel that the stage is set for a sharp upturn if the labor uncertainties can be cleared away.

• Small tools and supplies are moving steadily in Detroit but machine tools are practically at a standstill. Just as orders for tools and dies for several new models are becoming imminent the toolmakers threaten another strike. Regardless of the merits of their case the action is obstructing recovery. The labor situation in Cincinnati is quiet, which may be due to the fact that slackness in some machinery plants has caused lay-offs. Supply business is being obtained in fair volume.

• The recent Frisco order for several machine tools is the first to be closed in St. Louis by any railroad in a long time. Tool and die shops are busy. Conditions have changed little in Chicago in the last fortnight. Inquiries are more numerous, orders somewhat scarcer. Milwaukee also reports a slackening of orders. The Nash and Seaman Body disputes are disturbing many.

Trends in Machine Tools Indicated at Leipzig

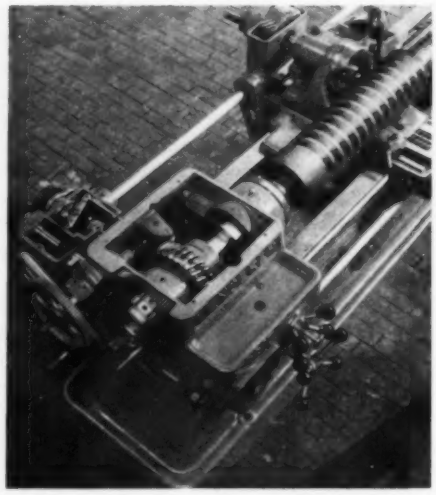
Leipzig, Germany—A decrease in the number of special machines in favor of those for universal service was one of the noticeable trends in the 1934 Spring Fair at Leipzig. Machines for precision finishing were extensively represented. Surface speeds of 200 to 250 ft. per min. for roughing and 6500 ft. for light metals constitute regular practice. These are, of course, intended for use with carbide or diamond tools.

V-belt drives were popular in the machine tool display. Regulation of speed is increasingly being effected by infinitely-variable mechanical transmissions of which the Heynau and P.I.V. gears are prominent examples. Insulating materials are widely used in control handles to improve operating conditions.

DRILLING MACHINES—In radials there is a tendency to reduce the number of controls. One feature is the clamping of the entire machine by a single push button switch. Otherwise no great modifications of previous designs are in evidence.

BORING MACHINES—The fine-boring machine, offered by the Werkzeugmaschinenfabrik Union, has two horizontal spindles of nitrided steel. The bearings of special bronze are adjustable radially and axially. During the return stroke the table is shifted a few thousandths laterally to save the finished surfaces.

Other designs are of the vertical spindle type. In that shown by Hahn & Kolb from one to six spindles may be used and adjusted as desired. Way surfaces are nitrided and the feed is hydraulic. The precision boring machine built by Krause & Co. has lateral traverse to the table which may be controlled by stops for producing multiple holes. Precision measuring instruments for locating the holes and gaging for depth are built into the machine. A similar design is offered by Hille-Werke.



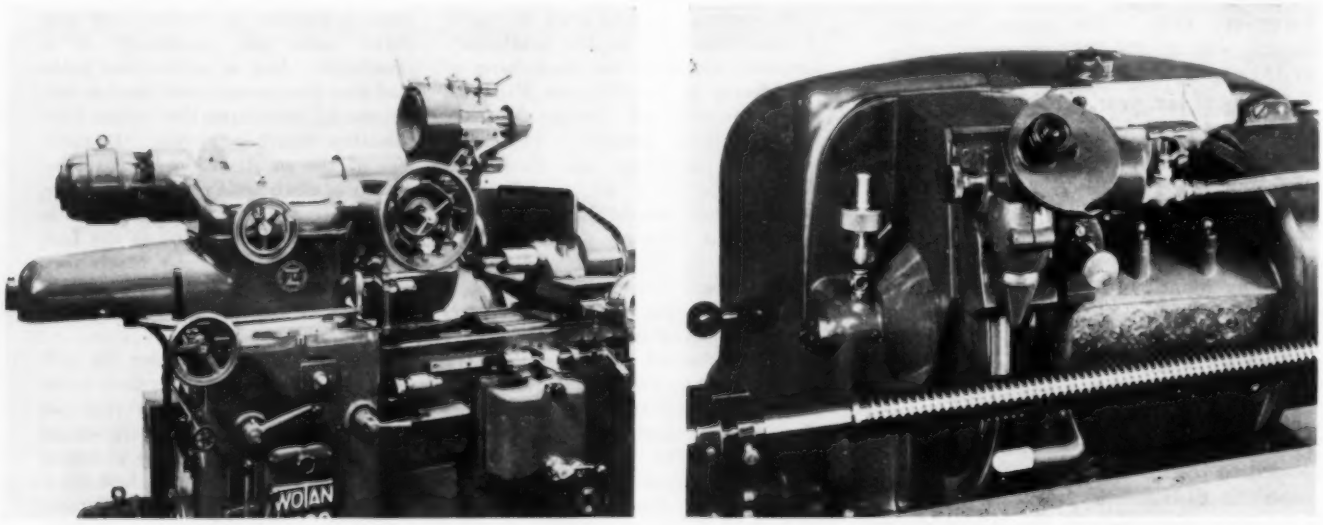
Heavy duty Wanderer milling machine is shown cutting a coarse thread

Among the jig borers that by H. Lindner has a heavy but well balanced boring head carried on a heavy ring by which it may be set at any angle. The table and boring head are adjusted by hardened and ground screws and their position indicated in scales within an accuracy of 0.00005 in. In the Hahn & Kolb jig borer the head is held in a vertically adjustable corssrail. The position of the rail is obtained by highly finished precision blocks in the uprights.

LATHES—A production lathe by L. Loewe has the drive in the lower part of the bed. The spindle has no gears of any kind, the drive being effected by a heavy belt. The Vereinigte Drehbank Fabriken line uses an enlarged gear box to allow the cutting of any standard thread without resetting the change gears. The driving pulley of the cone driven machine of Deutsche Niles-Werke is the revolving housing of the Himmel motor which is arranged on a hinged pedal-operated frame in the lower portion of the bed.

In the Magdeburger Werkzeugmaschinenfabrik hydraulic lathe the drive is transmitted from a flanged motor outside the bed to a Lauff-Thoma gear and thence through a V-belt to the spindle. Speeds are variable to any point from 50 to 1400 r.p.m. For large but light work, the Maschinenfabrik Ravensburg facing lathe has been designed. All motions of the compound slide are power operated.

The turret lathe built by Pittler has the individual motor drive employed for years by this firm's automatic screw machines. Drive to the spindle of the Magdeburger Werkzeugmaschinenfabrik is either through a sliding gear spindle or through a hydraulic head with a Lauff-Thoma gear. The aprons of the carriage and turret slide are combined



Left—Both internal and surface grinding may be done on this hydraulic Wotan design. Right—A microscope contained in a water tight housing permits an exact check on the form of both work and wheel on this Lindner thread grinder

into a central control station. This common control apron is also employed in the semi-automatic multiple tool lathe by Gebr. Heinemann. In the vertical automatic lathe, built by Bielefield, the carriage is suspended from ways above the work.

MILLING MACHINES—Electric controls are used to disengage automatically the feed in the planer type miller built by Kollmann. The table of the vertical spindle miller by Biernatski has longitudinal, cross, vertical and diagonal traverse controlled by three levers in the knee. The long screw millers of the Wanderer-Werke and Reinecker may be used either for the generating or the hobbing methods.

A machine only 3.3 x 3.3 ft. in area suitable for the production of jigs is the Model FP1 miller by Fr. Deckel. The broaching machine by Slotta has been made suitable for work with helical grooves by using special broaches.

GRINDING MACHINES—The heavy duty grinder by Wotan - Zimmermann is adapted to internal as well as to surface grinding. Reinecker offers a machine with both hydraulic table motion and hydraulic dividing head. The spindle can be swiveled to any position in a complete circle. All steel construction is used in the DCP and DVS surface grinders of the Diskus-Werke especially suitable for assembly purposes.

The centerless grinder of Hartex G.m.b.H. is arranged to use the straight-through, in-feed, in-and-out and through-feed methods. The table motion is hydraulic. A micro-optical setting and checking device is used in the thread grinder by H. Lindner.

PLANERS—Either two planing heads or one planing and one grinding head may be used on the Waldrich machine. Table motion is obtained hydraulically through oil cylinders. In the hydraulic shapers by Klopp and Wotan-Zimmermann all controls are on one side.

SHEET METAL-WORKING MACHINES—In the all-welded steel press brakes by Sonntag the lower jaw is carried by a circular joint to prevent the transmission of transverse stresses to the frame. Strips of 20-in. in width may be cut in the Berlin - Erfurter Maschinenfabrik rotary shear. The work is clamped to a table while a carriage carries the shear proper. The same firm builds a nibbling shear using a cutter reciprocating at 1400 strokes per minute.

A double bearing eccentric press by Hiltmann & Lorenz is provided with an air cushion for combined blanking and drawing. In the multiple press designed by the same firm for mass production as many as thirteen operations can be effected by a single stroke.

Any press may be converted for stagger feed by the "Ideal" blanking attachment of Kircheis. The required motion is effected by hand. The Schuler high speed press operates at 300 strokes per min. and has automatic feed and material removal. The wire forming machines of Semper & Co. are fully automatic with cam control.

In the Gebr. Gotz presses for resinous materials the required graduated pressure is attained mechanically by a double crankshaft system. In that by Hahn & Kolb, the pressure is applied hydraulically and regulation is effected by governing the oil at the intake.

German Diesels May Bid for Foreign Markets

WASHINGTON—Rapid growth and increasing development of the use of diesel engines in Germany, giving rise to expressions of fear that further improvement will produce formidable competition for American gasoline engines in foreign markets where they are now popular, has been reported to the Department of Commerce.

Germany has for some time been using diesel engines in railroad and airplane transportation and is now turning to their use in automobiles, trucks, tractors and power shovels. The rate of production of the latter vehicles and machinery increased greatly during 1933, it being estimated that between 70 and 80 per cent of all such vehicles now produced in Germany are equipped with diesel engines.

Savings in operation costs were given as the reason for the great interest in diesel equipped vehicles. Gasoline costs in Germany are high because it is practically all imported, but the country is capable of producing and does now produce gas oil and tar oil of local origin.

Reliable estimates are said to place the number of diesel powered units in the country at 10,000 units. About 4,500 diesel powered commercial vehicles were registered there in 1933, but this does not take into account the number of old vehicles equipped with new diesel engines.

Most commercial vehicle production in the country so far has been limited to trucks of two tons or more capacity, with a diesel motor costing as much as $560 more than a comparable gasoline motor in retail price. A number of firms are engaged solely in production of diesel engines for replacement of gasoline motors. The new diesel motor for trucks, tractors and power shovels is said to show a great improvement over the motor used in ships and for stationary purposes.

Interest is being shown in German diesel engines by the countries which likewise have no domestic gasoline supply. Tremendous demand in Germany and nearby countries for an efficient diesel passenger car retailing for $480 is predicted.

Fred Colvin Heads New Tool Committee

Technical Committee No. 19 on single point cutting tools has been organized under the sectional committee on standardization of small tools and machine tool elements under the procedure of the American Standards Association. This is sponsored by the National Machine Tool Builders' Association, Society of Automotive Engineers and the American Society of Mechanical Engineers. Fred H. Colvin is chairman of the new committee.

Metal-Working Code Hearings Scheduled

Date	Place	Deputy Administrator	Association
April 11	Commerce Bldg.	H. O. King	Washing and Ironing Machine Manufacturers (Amendments)
April 12	Washington Hotel	G. S. Brady	Road Machinery Manufacturers (modification)
April 16	Harrington Hotel	G. S. Brady	Compressed Air Institute (modification)
April 16	Harrington Hotel	G. S. Brady	Hydraulic Institute (modification)
April 17	Washington Hotel	L. S. Horner	Metal Jacketed Jug Manufacturers
April 17	Washington Hotel	L. S. Horner	Complete Wire & Iron Fence Manufacturers
April 18	Commerce Bldg.	W. A. Jannsen	Nickel Alloys

• PERSONALS •

WILLIAM SCOTT, formerly general superintendent of the motor plant, Chevrolet Motor Co., Flint, Mich., has been made factory manager of the Detroit drop forge and spring plant. A. G. SULLIVAN is general superintendent of manufacturing at Flint, under ARNOLD LENZ, general manager at Flint, Saginaw and Bay City. M. K. HOVEY, has been made general superintendent of the Flint motor plant and continues as chief inspector. H. F. HOWARD is now superintendent of the Flint assembly plant, being formerly manager of the commercial body plant at Indianapolis.

D. S. EDDINS, who recently joined the staff of the Chrysler Corp., has been made vice-president and general manager of the Plymouth Motor Corp.

E. J. STAHL, of the Baker-Raulang Co. was elected president of the Cleveland branch of the National Metal Trades Association, on March 28 at its annual meeting. Other officers are: vice-president, P. E. BLISS, Warner & Swasey Co.; treasurer, W. C. SAYLE, Cleveland Punch & Shear Works Co. The executive committee consists of: LOGAN MONROE, Eaton Mfg. Co.; P. A. GEIER, P. A. Geier Co.; J. D. COX, JR., Cleveland Twist Drill Co.; H. L. GADDIS, Globe Machine & Stamping Co.; L. W. GREVE, Champion Machine & Forging Co., and T. H. DOAN, JR., Foote-Burt Co.

WILLIAM H. WINTERROWD, vice-president of the Lima Locomotive Works, Inc., resigned April 1, to become vice-president of the Franklin Railway Supply Co.

J. H. BENDIXEN, has been made chairman of the board, first vice-president and manager of sales of the Bettendorf Co., Bettendorf, Iowa, E. J. BETTENDORF has been elected president and treasurer to succeed the late J. W. BETTENDORF.

B. B. WEINBERG, vice-president and treasurer of the Heppenstall Razor Co., Newark, N. J., has resigned to become vice-president and treasurer of the American Shear Knife Co., Homestead, Pa.

C. D. DALLAS, president of the Revere Copper and Brass, Inc., has announced the appointments of R. H. BINNS, JR., and S. H. WILSON, as assistant general sales managers, with headquarters in New York. Mr. Binns was manager of the Pacific Coast sales district and has devoted his time principally to merchandise sales. Mr. Wilson was in the Detroit office as assistant sales manager and specialized on industrial sales.

General Electric Submits Profit Sharing Plan

A plan by which nearly 50,000 employees of the General Electric Co. will share in profits was recently submitted to the company's stockholders by the board of directors. Under the proposal, the directors are given authority to set aside out of earnings of the company available for dividends, after deducting 8 per cent of the average book value of the common stock, an amount not in excess of 12½ per cent of the balance. Based on the present book value of the common stock, no participation can result under this plan until the annual earnings available amount to approximately 83 cents a share.

• BUSINESS ITEMS •

The Sheffield Machine & Tool Co., Dayton, Ohio, has made the following appointments: Buffalo representative: Don F. Johnson & Co., Inc., 156 Main St.; Pittsburgh representative: J. A. Bouslough, 606 North Ave., Wilkinsburg, Pa.

The Seneca Falls Machine Co., Seneca Falls, N. Y., lathe manufacturer, has announced that on April 1st., sale of its line in the Detroit territory was taken over by W. H. NETTLE, 236 Richton Ave., Detroit.

City Machine & Tool Works, Dayton, Ohio, has appointed the Don F. Johnson & Co. Inc., 156 Main St., Buffalo, N. Y., as representative in the Buffalo district for "Cimatool-Paulins" standard drill jigs and locks.

Work has been resumed by the Lynch Corp., Anderson, Ind., makers of glass-making machinery, on rehabilitation at the former Ames-Baldwin-Wyoming Shovel factory. New machine tool equipment will be purchased. The old plant in Anderson and the Miller division at Columbus, Ohio, will be merged with the new plant as soon as possible.

• OBITUARIES •

JAMES C. CARLTON, vice-president and general manager of the Calco Machinery Co., Philadelphia, machine tool dealers, died March 17 at the age of 48. He was the brother of JACK C. CARLTON, president of the Carlton Machine Tool Company, Cincinnati. After learning the trade of general machinist he started with the Electric Railway Equipment Co., and became assistant general manager. In 1919 he joined the Thompson Machinery Co., of Pittsburgh, but in 1921 went with the Sherritt & Stoer Machinery Co., of Philadelphia. The Calco Machinery Co. was organized in 1926.

MARCUS CHASE, 62, former sales manager of the Niles Bement Pond Co. of Massachusetts, died March 16. He was appointed sales manager of the company in 1912, and retired in 1928.

ALTON FARREL, 55, treasurer of the Farrel-Birmingham Foundry & Machine Co., Ansonia, Conn., died March 28. He was the grandson of the late Franklin Farrel, founder of the original Farrel Foundry & Machine Company.

HAROLD I. INGERSOLL, secretary of the Ingersoll Milling Machine Co., Rockford, died March 27.

ARTHUR W. KETTLE, 65, president of the Two-Way Shock Absorber Co., Jamestown, N. Y., and a director of the Marlin-Rockwell Corp., at Jamestown, died March 30.

JOHN HAMMOND KIMBALL, who resigned two years ago as mechanical superintendent of the Lynn Works, General Electric Co., died March 18.

WILLIAM WALLIS, advertising manager for the Hill Publishing Co., over 30 years ago, died March 27, aged 66. He had a wide acquaintance in the machine building industry a quarter of a century ago. More recently he was vice-president of the Hitchcock Publishing Co., Chicago.

JAMES E. WOODBRIDGE, 79, at one time head of the small tool division of the Pratt & Whitney Co., died March 25.

• MEETINGS •

AMERICAN GEAR MANUFACTURERS ASSOCIATION. Annual meeting. May 3-4. Penn-Lincoln Hotel, Wilkinsburg, Pa.—headquarters of association. J. C. MCQUISTON, secretary.

AMERICAN SOCIETY FOR TESTING MATERIALS. Annual meeting, June 25-29. Chalfonte-Haddon Hall, Atlantic City, N. J. A. E. Hess, assistant secretary, 260 South Broad St., Philadelphia, Pa.

AMERICAN SUPPLY & MACHINERY MANUFACTURERS ASSOCIATION. Convention. May 22-23. Netherland Plaza Hotel, Cincinnati. R. KENNEDY HANSON. secretary, 604 American Bank Bldg., Pittsburgh, Pa.

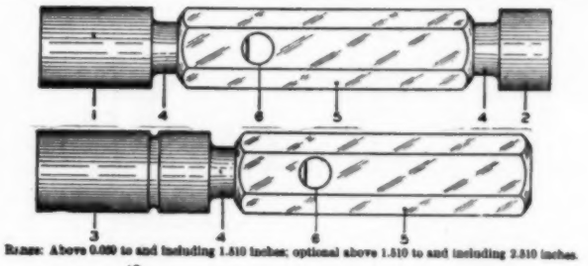
CHAMBER OF COMMERCE OF THE UNITER STATES. Twenty-second annual meeting. May 1-4. Washington, D. C.

NATIONAL METAL TRADES ASSOCIATION. Thirty-sixth annual convention. April 25-26. Waldorf-Astoria Hotel, New York. J. E. NYHAN, national secretary, Peoples Gas Bldg., Chicago, Ill.

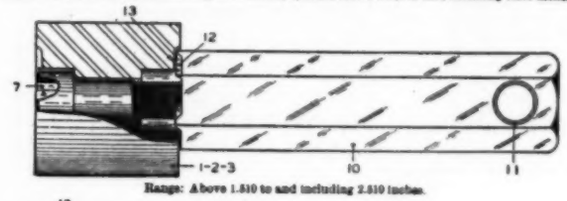
American Gage Design Standards

Commercial Standard CS8-33. American Standard B47-1933

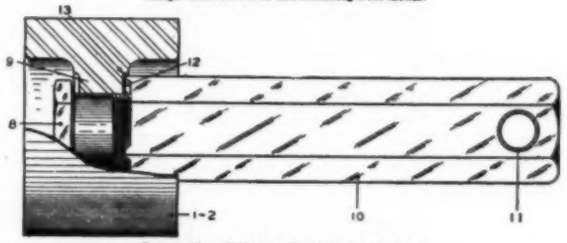
Issued Dec. 22, 1933. Effective for production Jan. 1, 1934.



Range: Above 0.059 to and including 1.510 inches; optional above 1.510 to and including 2.510 inches.



Range: Above 1.510 to and including 2.510 inches.



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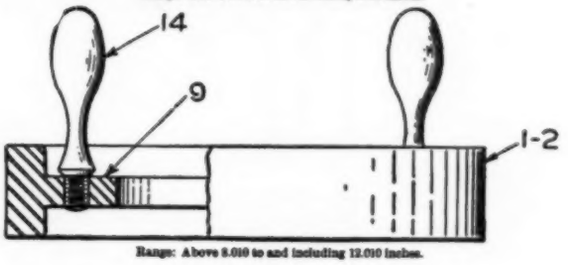
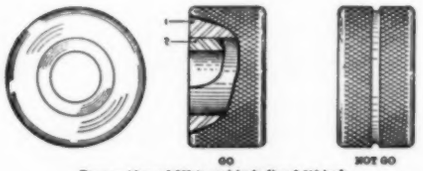


Range: Above 8.010 to and including 12.010 inches.



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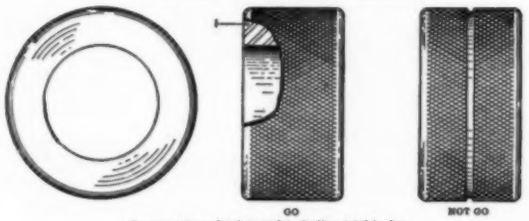

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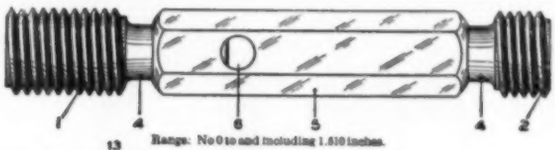
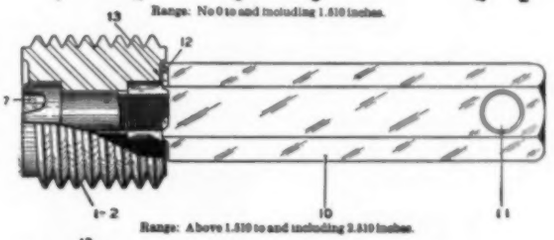
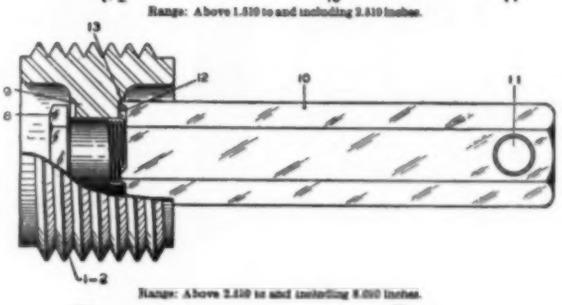


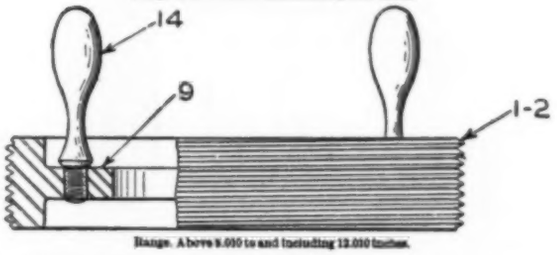
Range: No 0 to and including 1.510 inches.



Range: Above 1.510 to and including 2.510 inches.

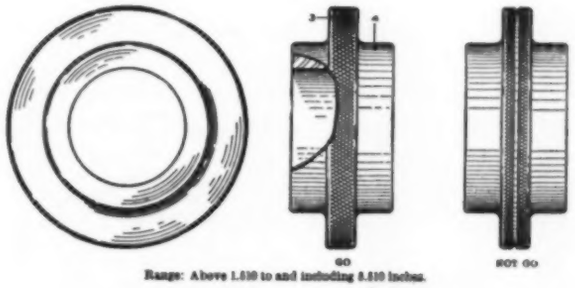


Range: Above 2.510 to and including 8.010 inches.

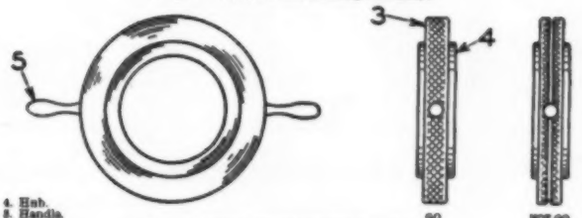


Range: Above 8.010 to and including 12.010 inches.

1. "Go" gaging member
2. "Not go" gaging member
3. Progressive gaging member
4. Shank
5. Taper lock handle
6. Drift hole (or slot)
7. Socket head screw
8. Hexagon head screw
9. Web
10. Handle for reversible gage
11. Cross-pin hole
12. Locking prong
13. Locking groove
14. Ball handle



Range: Above 1.510 to and including 5.510 inches.



1. Body.
2. Bushing.
3. Flange.
4. Hub.
5. Handle.

Range: Above 5.510 to and including 12.260 inches.

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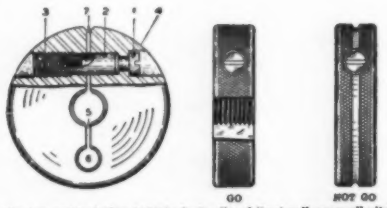
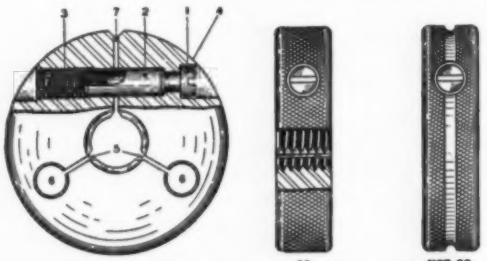
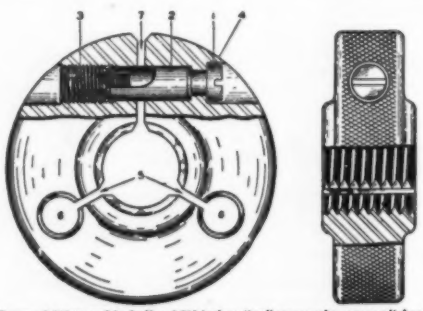


Range: No. 0 to and including 0.365 inch, "go" and "not go" gages, all pitches.

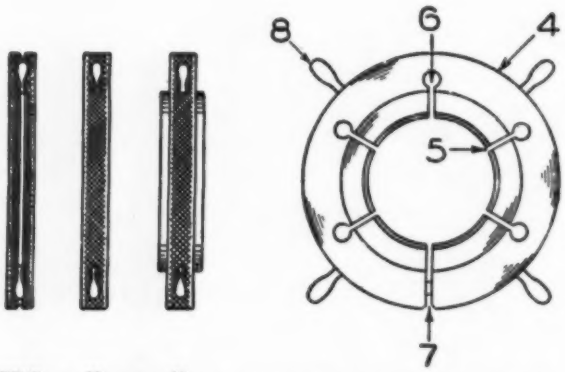


Range: 0.365 to and including 0.510 inch, "go" and "not go" gages, all pitches; 0.510 to and including 5.510 inches, "go" and "not go" gages, fine pitches; 0.510 to and including 5.510 inches, "not go" gages only, coarse pitches.

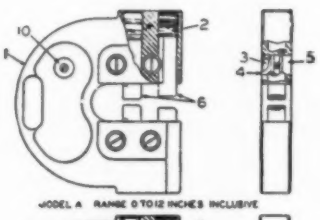


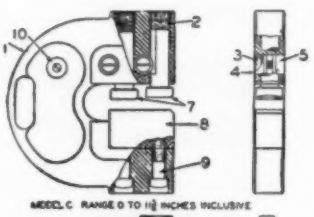
Range: 0.510 to and including 5.510 inches, "go" gages only, coarse pitches.

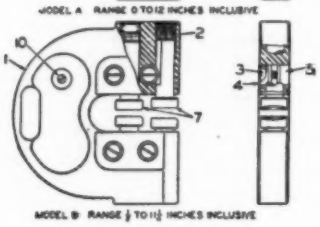
1. Locking screw
2. Sleeve
3. Adjusting screw
4. Body
5. Adjusting slot
6. Adjusting slot terminal hole
7. Locking slot
8. Ball Handle

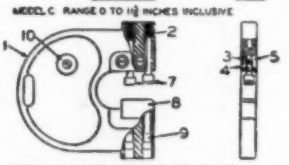


Range: 5.510 to and including 12.260 inches. Thick blank for coarse pitches, "go" gages. Thin blank for fine pitches, "go" gages, and all "not go" gages.

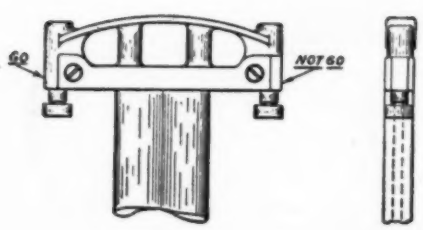


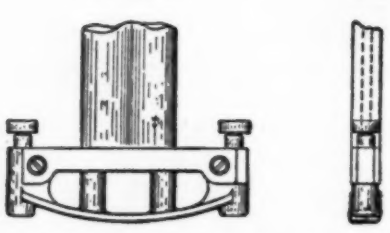






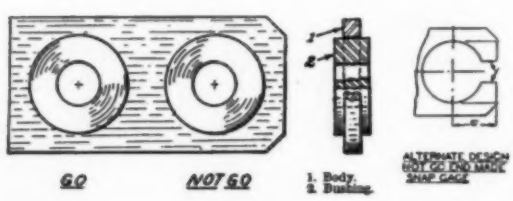
1. Frame
2. Adjusting screw
3. Locking screw
4. Locking bushing
5. Locking nut
6. Gaging pin
7. Gaging button
8. Anvil
9. Anvil screw
10. Marking disk





Adjustable length gage assembly, double sided model.

Progressive model has two pairs of gaging members on same side of spacing bar



Range 0.059 to 1 135 in.

THE ROUND TABLE

Unions—Horizontal or Vertical?

"Al, you're the fellow who knows all about unions and such things. What's this I hear about horizontal unions and vertical unions? I might try to be funny and ask if the horizontal unions took it lying down and the vertical chaps stood up for theirs, but even I know better than that."

"The terms are a bit confusing, Ed, but suppose we think of the horizontal unions as craft unions. This means the machinists', toolmakers' or patternmakers' unions are all separate as we have them now, and includes machinists or toolmakers in all kinds of shops. Vertical unions are organizations that cover everyone in a single plant or in an industry."

"Isn't that the same as a company union, Al?"

"Only if it is organized by the company. If the men in any big shop organized into one union regardless of trade or occupation, that's a vertical union."

"Sort of knocks the idea of pride in skilled trades, doesn't it? Why should a good toolmaker join up with a turret lathe operator who can't set up his own machine, Al?"

"I'm not saying he should. But why shouldn't he? They both work in the same shop and if conditions are bad both suffer from them. If it's a matter of wages it's a safe bet that if one kind of man gets less than the going rate, they all do."

"But how can the men in different trades agree on what each should get? Won't it mean that all will tend toward the same level? With the craft or horizontal union each trade tries to set its own wage but not those of other trades. Here they'd all be working together. Which would you rather have in your shop, Al?"

"Frankly, I'm not so keen on having either. But if unions are part of the picture, I think I'd take the vertical union."

"I think you're wrong, Al. Suppose the toolmakers in town feel they ought to get more money. They get together with the other toolmakers and make demands, maybe go on strike. That won't tie you up nearly so badly as to have all your men go out."

"That's true, Ed. On the other hand one department will sort of balance the other and if men in one department get too cocky the other men won't jeopardize their job by going out without a good reason. I'm inclined to believe that where all departments are in a single union, or whatever you want to call it, you'll have less uneasiness through the shop. Of course if they do go out it ties up the whole shop. But if the great majority of the men are dissatisfied, there's pretty likely to be something for the management to look into."

"On the other hand, Al, take toolmakers in a dozen shops. Some of them might be poorly paid or work too many hours, of course. But there would be some shops where conditions were O. K. and those men wouldn't go out. I think you'll have less trouble with the 'laying down' unions."

"There's another point for the vertical union Ed. I believe any good management will get, and deserve, more of a spirit of loyalty where all the men belong to one organization. We've had some notable examples of that with plant organizations where the company kept hands off completely."

"But what if your vertical union ties up with the A. F. of L. or any other national organization?"

"Why is that any worse than with the crafts union? A national organization can call out men by either method. But, badly as I dislike it, I can't see that it's any worse than the national organization I belong to. We are all supposed to stick together, whether the men in our shop are involved or not. We can't expect all the plums to fall on one side of the fence."

Which type of union will attract the best men as members or as leaders?

What alternative to unions offers as much or more?

Will the vertical union secure more stability in a shop?

Discussion

What Share?

There is no definite standard for the share labor earns in business. In a well organized business, where labor is highly skilled and above average intelligence, its share should be much greater than in a business where leadership is lacking and where the average intelligence of labor is low.

It is up to the working man to get in with a progressive company, where leadership if is the highest type. Just as the investor or stockholder selects a company for investment, which in his mind has a prosperous future, so should a working man try to choose an employer that will give him satisfactory employment. In other words, a working man's share may be much less in one

company than it will be in another company, though his services are exactly the same.

To be considered fair a firm must at least:

1. Pay a minimum wage on which a man can support a family;

2. See to it that all employees are given an opportunity to advance themselves.

Time has shown the advantage of paying a bonus to certain higher executives; but excessive bonuses and unreasonable high salaries to a few should be avoided.

The share of labor in a firm should be altogether in the pay envelope and not in the management of the business. The old saying "Too many cooks spoil the soup," holds good here too.

—NILS H. LOU.

The share of labor in industry is good wages only. These wages must be the highest possible consistent with low selling prices, low overhead and fixed charges. Wages must be based not only on the amount of production but also on the skill and intelligence required to do the work.

Labor is neither ethically nor actually entitled to a share of the net profits. In no industry does labor take any risk in regard to financial rewards. It always demands and receives a guaranteed return for its efforts. This stand puts labor in the same general class as owners of bonds or preferred stock. There is a slight difference however, as bondholders and preferred stockholders may have their wages of interest and dividends delayed for various reasons and periods of time. But wages for labor must be paid first.

Contrary to the belief and teaching of many people, labor does not make the profits. In fact labor in itself is an impotent force. It must have capital before it can work. In order to work effectively and profitably it must have supervision or management. Before a profit can be realized salesmanship must be called upon.

Capital does not make the profits altogether. It supplies the means for labor to produce. But management and salesmanship must be called upon for labor to produce effectively and to sell the product of labor. However, no profit is made until the products have been sold and the selling price collected. This may take place immediately or not for a long time. In the meantime labor has been paid for working. Capital has to wait for its share until the product has been paid for. If the product does not sell at a profit capital must bear the entire loss. Labor is always unwilling to stand any of the loss. As capital is the one that takes all of the risks, it is the one which should take all of the profits.

When bonuses or profit-sharing is given to labor, without any increase in production, it can be done only for three reasons: Wages were too low in the first place; philanthropy on the part of the company; or there was profiteering through too high selling prices.

—L. O. BROWN.

NRA and the Small Shop

The law states plainly that the codes must not operate to discriminate against small enterprises. But as a matter of fact there are provisions in the codes that do operate against small shops. Protests by the owners of these shops against what are claimed to be discriminations receive replies something like the following:

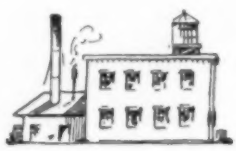
"Dear Mr. Forbes:

Thank you for your letter of July 28. You may be sure it will have full consideration.

Yours very truly,
W. L. ALLEN,
Deputy Administrators"

In the meantime the code is in operation, and subsequent inquiries have all brought similar replies. The discrimination may be satisfactorily adjusted some day, but no one knows whether it will be in the present administration.

For examples of the kind of discrimination, I will mention a few from the proposed code for the electrical tool manufacturers. I do not want to say that these provisions were intentionally made discriminatory. I think it more probable that the large plants consider



their own methods best, and think the industry would be benefitted by all using the standard practice which they have adopted. But in deciding upon standard practice they have ignored the rights of the others.

Article IV, Section 2, permits the mass production plants to give a discount of 30 per cent on tools sold from stock over the counter. But it only permits the small plant building special tools sold more on an engineering basis to give a discount of 15 per cent. It is more work to sell the special tool than the mass production product, so naturally such a discrimination in commissions will give the advantage to the mass production plant.

Article IV, Section 6, establishes a standard guarantee. Many small plants make a superior article for sale at a higher price. But with a standard guarantee they would not be allowed to get full benefit from superior quality.

Article V, Sections 3 and 5, prohibit the manufacturer from consigning stock to distributors or to guarantee the sale of purchased stock. It is not necessary for the manufacturer to consign stock of a well known product, for the dealer is in a position to make a good estimate of the demand. But for an unknown product, the consignment of stock is often the most economical and the best method of introducing the product. Such a prohibition is discrimination in favor of the best known.

Article V, Section 6, prohibits trials for more than 30 days. This is long enough for most cases. It is long enough for any of the mass production goods. But it is not sufficient for many of the products of an engineering nature.

It is true that this code is not yet signed, and it is to be hoped that some of these discriminatory measures will be eliminated. But it is also clear that the large companies intend to put over these measures by claiming that they do not discriminate. And it is also possible that they will convince the administration that they do not. For the administration knows nothing about the nature of these business practices and are too likely to be influenced by the best lawyers.

—A. W. FORBES,
Forbes & Myers.

No Inventory

Our industrial life is passing through a transitory period and the feeling of uncertainty has caused inventories to be reduced, thereby reducing the capital outlay for materials not immediately needed. The question of inventory must not be confounded with work in process. What is meant by inventory is those parts that are normally carried in stock, either rough or finished.

The trend of the times makes necessary a drastic reduction of inventory, because buyers are buying from hand to mouth and this condition results in slowing manufacture. Many of the automobile companies have so regulated their inventories as to allow but a 30-day supply of all materials on hand at any one time. Even this investment could be reduced if it were not for the possibility of unforeseen conditions that might arise.

All enterprises, large and small, must know the amount of their inventories at the close of each year, if for no other reason than to make up their income-tax reports.

—HAROLD L. WYNN,
Executive Engineer,
Pacific Electric Mfg. Corporation.

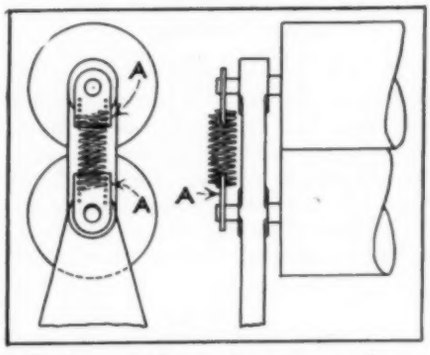
· IDEAS ·
FROM PRACTICAL MEN

Fastenings for Tension Springs

CHARLES BRAU

The usual method of attaching tension springs is to bend the last coil at each end into an eye, and to hook the eyes over pins. This method does not allow for adjustment except by moving the pins. If the parts to which the spring is attached revolve, the eyes will be subject to wear and may break.

A better method of attaching the springs is by plates having holes through



Springs without "eyes" can be threaded into plates having holes to suit the wire and the pitch of winding

which the spring ends are threaded, as shown in the illustration at *A*. The holes are drilled to fit the spring wire and are spaced the same as the pitch of the spring. The spring then becomes a straight helical spring without eyes. If more or less tension is required, it is necessary only to unhook one plate and to screw it farther on or off of the spring.

Boring Attachment for a Lathe

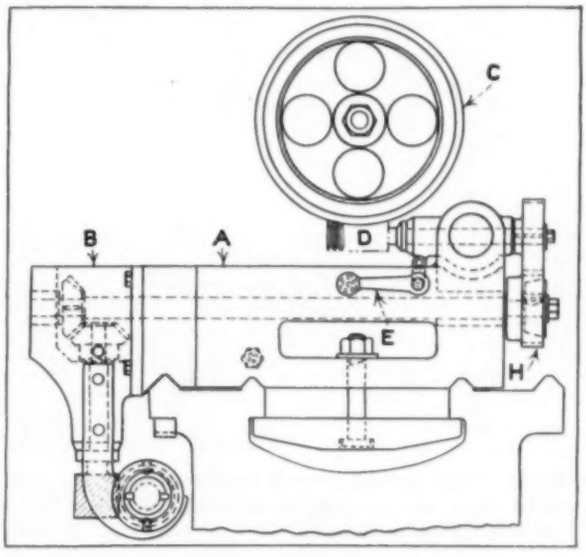
EUGENE L. SOLTNER

Periodically we received orders for hollow shafts varying from 6 to 14 in. in diameter, 5 to 8 ft. in length and 4 to 10 in. bore. Rough drilling was done with a flat drill in the usual way, drilling half-way through from each end to the center, the drill being supported by the tailstock center, prevented from rotating by an adapter on the carriage, and fed by turning the tailstock handwheel with a long, claw-like wrench that fitted over the spokes.

After completing the rough drilling, the hole was counterbored to finished size about one inch from the end with a tool held in the toolpost. A bar having a bushing to fit the rough-drilled hole and fitted with a floating cutter just behind the bushing was then substituted for the drill. The cutter was ground on the ends to fit the counterbore, cutting being done by the front edges only. With the bar supported by the tailstock center and prevented from rotating by a clamp bearing on the carriage, the finish boring proceeded in the same way as in rough drilling. With the hole counterbored to start the cutter straight and true, and with the cutter floating in the bar, it is remarkable how straight a hole can be bored.

There was not enough work of this kind to warrant the purchase of a boring machine, yet filling an order meant at least a week of back-breaking toil for the man who did the job. However, at my suggestion, the device illustrated was made to fit one of our heavy-duty lathes. The two castings *A* and *B* were machined to fit the lathe, taking the place of the carriage and the apron, respectively. Replacing the tailstock handwheel is the wormwheel *C*, to which motion is transmitted by the worm *D* by a helical gear on the lead screw through the various gears and shafts shown. The worm shaft is pivoted and the worm can be moved in or out of mesh by the lever *E*. Thus, power for feeding the tailstock spindle is taken from the lead screw, and all available changes of feed can be obtained from the change gears.

The gear *H* is one member of a friction clutch, and will slip in case of overload from any cause, stopping the feed. Since the work of feeding the drill and the boring bar is now done by power, the back-breaking part of the job has been eliminated.



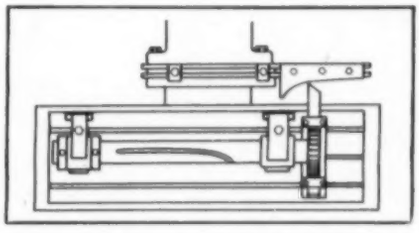
How power for feeding the drill was transmitted to the tailstock spindle

Cutting Compound Grooves

P. W. NIELSEN
Wallasey, Cheshire, England

We had a number of shafts that were to be grooved parallel with their axes to a point from which the grooves were to be helical, gradually increasing in pitch, for one fourth of a turn.

A steel plate having the profile of the helix was mounted on an angle plate attached to the column of a vertical milling machine, as shown in the illustra-



The shaft was rotated for milling the helical part of the groove by the combination of the rack, pinion and profile plate

tion. A shaft was clamped in V-blocks on the machine table, being collared to prevent endwise movement. To one end of the shaft was fitted a pinion that meshed in a rack having an extension bearing against the profile plate, being kept in contact therewith by a weight (not shown) attached by a cord to an arm clamped on the shaft.

After the straight part of the groove had been milled, the clamps were loosened enough to permit the shaft to revolve. The rack extension, bearing on the profile plate, rotated the shaft through the pinion as the table traveled, thus causing the end mill to cut the helical part of the groove.

Holders for Pull Broaches

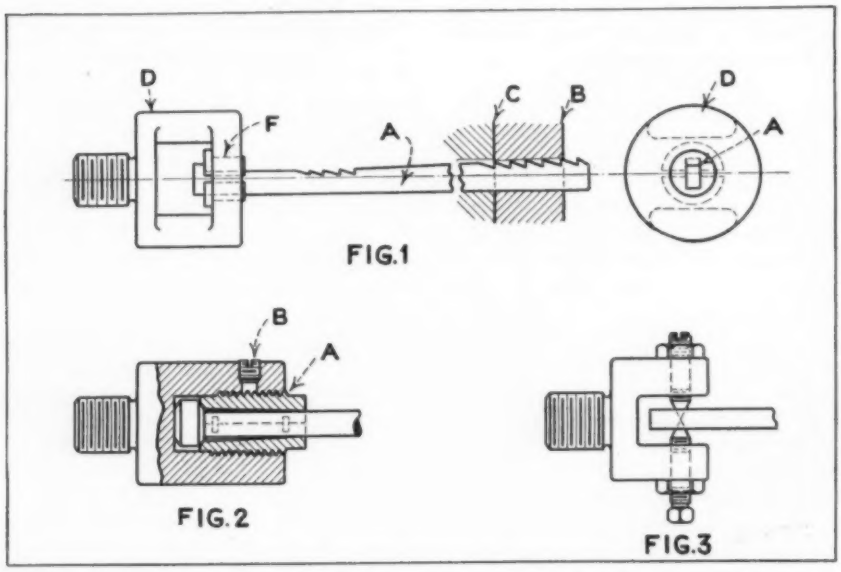
F. SERVER

When arranging tools for pull broaching it is necessary to consider the means for securing the broaches in the holders. While broaching machines are equipped with standard holders, it is sometimes advisable, because of the nature of the work, to employ special holders.

Three methods of securing broaches to their holders are shown in the illustration. Referring to Fig. 1, the broach is indicated at *A* and is being pulled through the work *B*, which is held against the surface *C* of the machine. The pulling device consists of the holder *D*, which is cut away through the center, and the split bushing *F*, fitting over the broach shank so that the shoulder is drawn tightly against the bushing. To remove the broach from the holder, it and the bushing are slid toward the machine. As soon as the bushing is clear of its hole, the halves of the bushing can be separated and the broach can then be removed by sliding it to the right, the head on the shank passing through the hole for the bushing.

In Fig. 2 is a unit for permitting the broach to float in the holder, so that a finishing broach will align itself and follow a hole that has been previously rough broached. In the holder is the threaded sleeve *A* having the outer end squared for a wrench. The broach shank has a head having a slightly rounded end, which, in combination with the slightly bell-mouthed hole in the sleeve, permits the broach to float slightly. The sleeve is in halves that are pinned together and is locked in place by the screw *B*, which has a brass shoe under it to prevent marring the thread.

A very simple holder for light broaching is shown in Fig. 3. The holder has two pointed screws to engage diametrically opposite holes in the broach shank. While broaches of several sizes can be held in a holder of this kind, they should be supported at the cutting ends.



It is sometimes advisable to design special broach holders. Each of the three holders illustrated above has been designed to suit the class of work to be broached

Grips for Die-Stock Handles

FRANK W. BENTLEY, JR.

In cutting threads with small die-stocks that have smooth handles, the job will be made easier if the handles are provided with "grips" such as are used on the handle bars of children's tricycles. The grips are made of tough rubber and a pair of them can be bought

Handle-bar grips on die-stock handles furnish a good hold when the hands are moist or greasy

for a nickel at almost any 5- and 10-cent store.

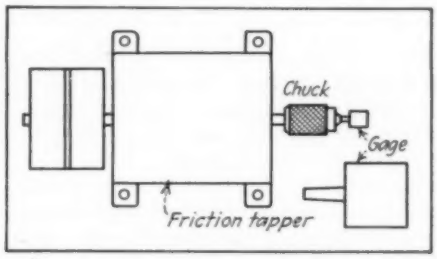
When the hands are moist, sweaty, or slippery with oil, the grips furnish a good hold and are very convenient. The illustration shows the scheme.

Gaging with a Friction Tapper

C. O. BRADFORD

At the present time there is no novelty in the use of a friction tapping machine for gaging threaded holes. What is not generally known is, that a friction tapper, will gage the size of unthreaded holes much more accurately and quicker than can be done manually.

Using a twisting motion when inserting a plug gage seems to be an instinctive motion especially if the gage is tight, and a friction tapper running at moderate speed makes the extra motion unnecessary.



Time is saved by using a friction tapper for gaging plain holes

Using the tapper also lessens the cost of making gages as only the sizing portion, and a short shank for holding it in the chuck are necessary. So many more pieces per hour can be gaged by this method, that the life of the gage seems shorter, and to avoid error it is better to make the gages a trifle undersize, plate with copper and then with nickel or chromium. The final coat should have a thickness of the allowable wear of the gage. When the copper plating shows the gage should be replated.

A Group Milling Fixture

H. THORNTON

In the ancient city of Przemysl, Galicia, many shops are engaged in reconditioning machines of various kinds, all of which are supplied with improvised replacements. The most frequent substitute parts are screws and bolts—inconspicuous replacements were it not for the trick of putting triangular heads on them, as in Fig. 1. Perhaps the want of square or hexagon bars explains the triangular heads, for round bars only are used—or is it more economical to machine three faces instead of four or six?

That ingenuity is not wanting in Przemysl is evidenced by the fixture illustrated in Fig. 2. The base *A* has a sleeve retained within it by a flange and a threaded collar, so that it can be rotated and locked in position by the index pin *B*. To the flange is attached the plate *C* having a triangular opening at *D*. At the lower end of the sleeve is attached the three-legged spider *F*, the position of its legs corresponding with the corners of the triangular opening in plate *C*. The collet *H* is screwed into the spider and is expanded by a screw having a tapered head.

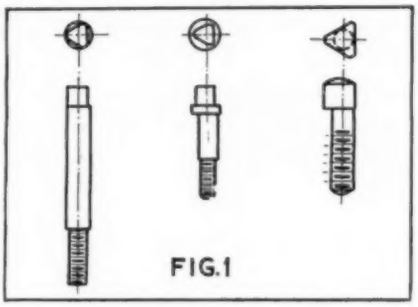


Fig. 1—For the want of square and hexagon bars, heads of screws and bolts are milled, triangular shapes being general

Screws to be milled are inserted between the head of the collet and the corners of the triangular opening in plate *C* and are wedged into the corners by expansion of the collet being securely held in alignment and spacing. The work is prevented from moving downward by its lower end resting upon the legs of the spider. In the case of shorter screws, the ring *K* is inserted into the sleeve, the lower ends of the screws resting upon it. Where screws have integral collars under the heads, the collars rest directly on the plate *C*. The top of the fixture is free from all projections, and ample clearance for chips is provided by the openings between the spider legs.

For milling triangular heads, the cutters are arranged as shown in the upper right-hand corner, one face of each of three pieces is milled at a time, the fixture being indexed for the other faces. The novelty of the fixture lies in the use of the collet for group clamping. By arranging the cutters as shown in the upper left-hand corner, hexagon heads can be milled. For square or octagon heads, plate *C* and the spider *F* are replaced by a plate having a square opening and a spider having four legs as shown at the left center, the sleeve being provided with the correct number of holes for indexing.

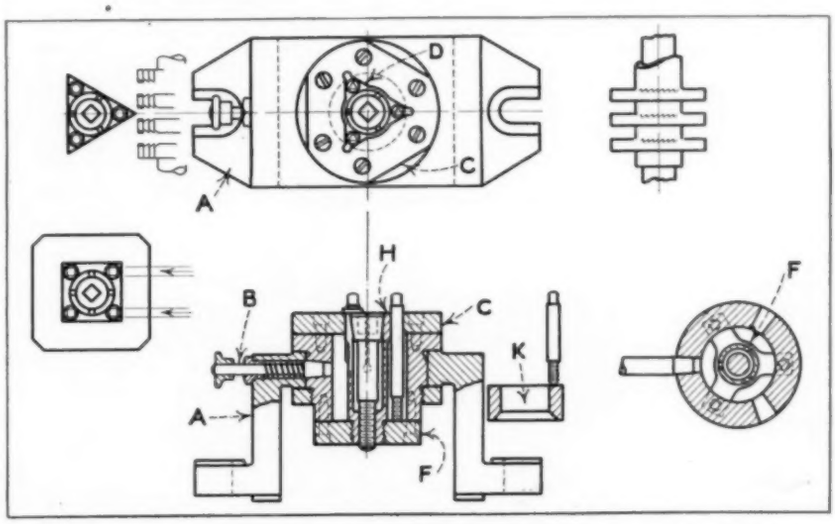


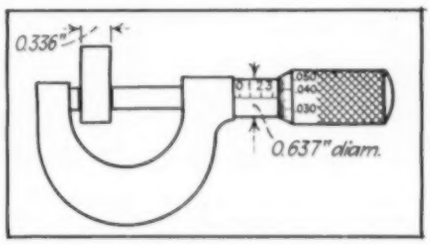
Fig. 2—Screws and bolts are wedged into the corners of the triangular opening in the upper plate by expanding the head of the collet

An Improved Micrometer

C. W. HINMAN

The present micrometer is based on a spindle thread of 40 per in. Experience has shown that such a tool requires too much time in opening and closing. It is also difficult to read quickly without squinting, turning the thimble forward and back.

The accompanying sketch represents a micrometer that has rapid opening and closing features, and also a simple graduating scheme that is easy to read. It is based on decimal tenths of an inch. The spindle threads have a lead of 0.100 in., or 10 threads per inch. The threads are in multiple and may be double, triple, or even quadruple if necessary. A coarse thread lead makes it easier to take accurate measurements. It eliminates jamming a half-thousandth of an inch past the correct measurement—a fault so common in the present tool.



This micrometer can be opened and closed quickly, is easy to read and will not jam on the work

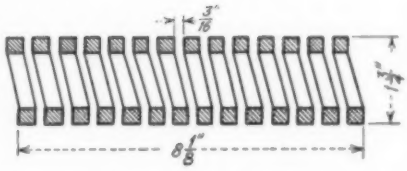
For this reason no ratchet stop is necessary on this micrometer. The graduations on the barrel are $\frac{1}{10}$ in. between. This feature makes clear and quick reading possible, since the three other confusing lines between, as on present micrometers, are omitted on this tool.

On the beveled edge of the thimble the graduations are an even hundred and are equally spaced around a diameter 0.637 in. This allows 0.020 in. between the lines, which is sufficient for easy reading. If these 0.020-in. graduations are thought too small, a slight increase in the diameter of the barrel will spread them farther apart. Obviously, each division on the thimble represents 0.001 in. on the work to be measured. These graduations are numbered at each tenth division, advancing by tens, as shown, with shorter central lines between, each representing 0.005 in. on the work.

This design for a micrometer is easy to understand and to explain to an apprentice, or to the boys in manual training schools, and in addition it will save the journeyman many a perplexing halt in reading as compared with the present commercial tool. Half-thousandths of an inch can easily be seen midway between any of the thousandth divisions, or fractional parts of a thousandth be accurately estimated. If desirable, the usual vernier can be added to the barrel for more refinement. The tool illustrated is set to caliper a thickness of 0.336 in.

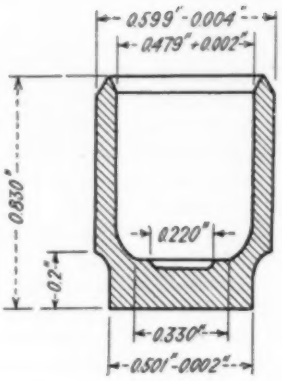
Press Work Pressures

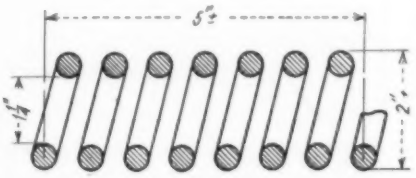
Series XXXII— *Miscellaneous Operations*



Material--Steel wire, 1/4 in. sq. 19 coils
Operation--Compress 1 in. from free length; took 170 lb.

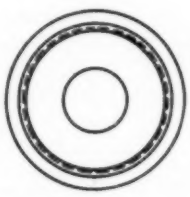
Material--Steel wire, 7/32-in., wound 2 coils per inch
Operation--Will compress to 6-3/4 in. long
Pressure--When compressed 1-1/2 in. from free length took 90 lb.



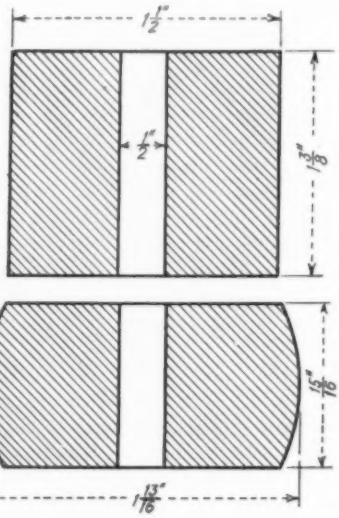


Material--Steel wire, 11/32 in. round
Operation--Compress to 4-1/2 in. long - 100 lb.
" 4 in. " 400 "
" 3-3/4 in. " 550 "
" 3-1/2 in. " 600 "

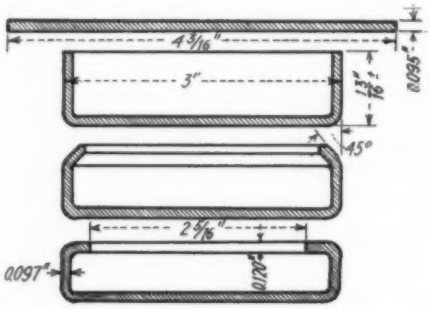
Material--Steel wire of various diameters
Operation--Spring made of 3/8 in. steel wire compressed to 4 in. took 1,400 lb.
Made of 11/32 in.; took 800 lb.
Made of 5/16 in.; took 740 lb.



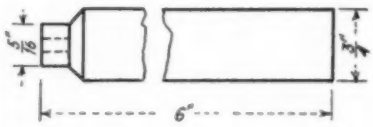
Material--Cartridge brass, 0.480 in. in diameter by 0.565 in. long
Operation--Extrude a cup
Pressure--80,000 lb.



Material--Rubber for combination dies 1-1/2 in. diameter by 1-3/8 in. deep
Operation--Compress to various thicknesses
Pressure--Compressed 1/16 in. 65 lb.
" 1/8 " 110 "
" 3/16 " 170 "
" 1/4 " 235 "

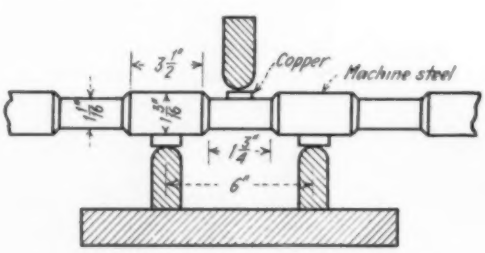


Material--Soft steel, 0.095 in. thick
Operation--Close in brake drum
Pressure--40,000 lb. to flatten flange to final shape

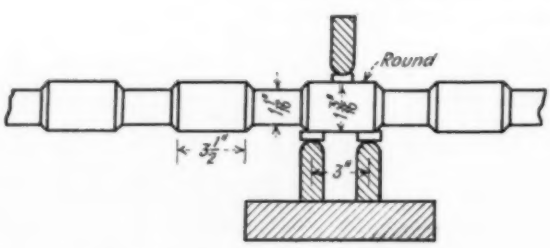


Material--Tin
Operation--Extrude a tube

	Pressure
Diam. of tube 1/2 in.	
Length of tube 6 in.	25 tons
Diam. of tube 1 in.	
Length of tube 6 in.	45 tons
Diam. of tube 3/4 in.	
Length of tube 6 in.	30 tons
Diam. of tube 1-1/4 in.	
Length of tube 6 in.	60 tons
Diam. of tube 2 in.	
Length of tube 6 in.	130 tons



Material--Machine steel, case hardened
Operation--Bend and set the roll
Pressure--11,000 lb.



Material--Machine steel, case hardened
Operation--Bend and set the roll
Pressure--20,000 lb.

Contributed by C. W. LUCAS

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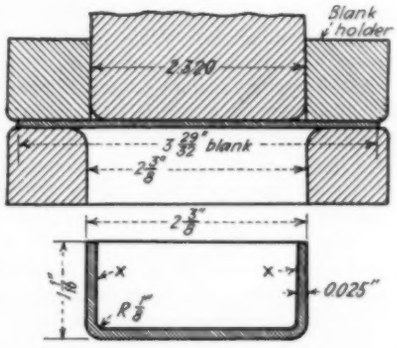
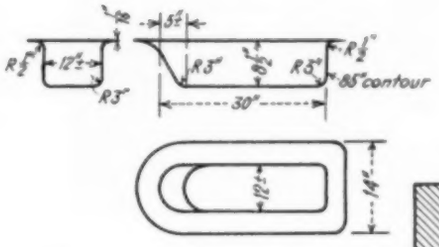
Press Work Pressures

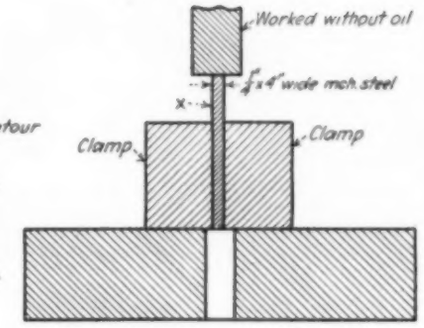
Series XXXII— *Miscellaneous Operations*



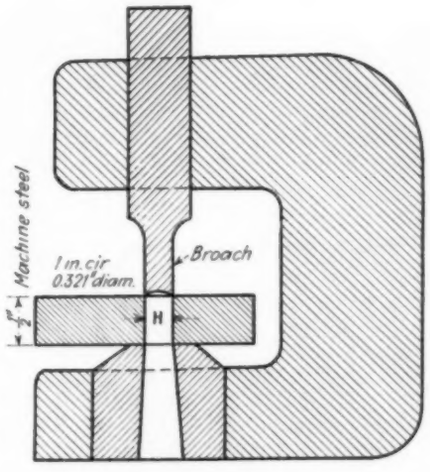
Material--Low-carbon steel. Blank 2-29/32 in. in diameter by 0.025 in. thick
Operation--Draw cup 2-3/8 in. in diameter
Pressure--5 tons. 5.6 tons would tear it apart at x - x



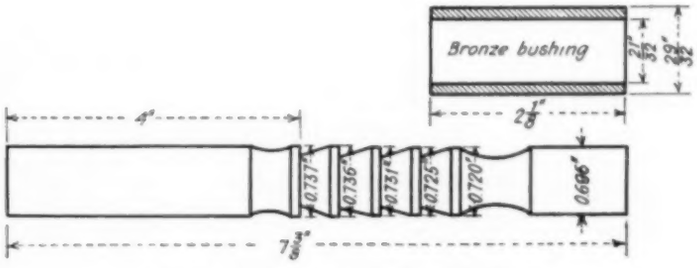
Material--Steel, 1/16 in. thick
Operation--Draw half-size bath tub
Pressure--260 ton, double-action press used



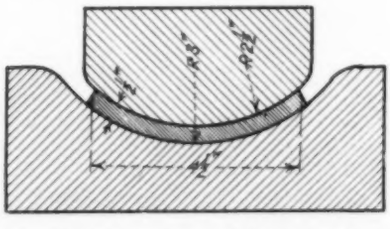
Material--Machine steel, 1/4 in. thick by 4 in. wide
Operation--After clamping tight by the use of two 7/8-in. bolts, piece marked X required 2-1/4 tons pressure to cause it to slide down through the two clamps
Note This test was undertaken to find the effect of tightly fitting a punch



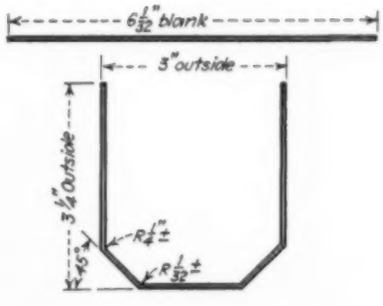
Material--Machine steel, 1/2 in. thick
Operation--A-Broach out hole (H) with sharp broach
B-Broach out hole with dull broach
Pressure--A-3,000 lb.
B-3,300 lb.
(Took out 0.0065 in. on a side)



Material--Bronze bushing, 2-1/8 in. long
Operation--Broach the bushing
Pressure--35-ton press



Material--Machine steel, 1/2 in. thick by 7/8 in. wide
Operation--Form strip into a curve with a radius of 3 in.
Pressure--8,000 lb.



Material--Drawing temper brass, 6-1/32 in. in diameter by 0.040 in. thick
Operation--Draw in cutting and drawing dies
Pressure--140,000 lb.

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SHOP EQUIPMENT NEWS

Williams, White Hydraulic Tube Bending Machines

Hydraulic, high-speed, universal and special tube benders are now being offered by Williams, White & Co., Moline, Ill. Both types of machines are fitted with two motor-driven hydraulic pumps. Each pump line has an adjustable pressure relief valve, one for the pressure required to clamp the tubing, and the other for the pressure required to swing the wiping-die cylinders. Such appurtenances as the oil tank, pumps, motor, piping and valves are located in an oil pan that is mounted high enough to provide foot room for the operator and to permit sweeping under the machine.

The machines are equipped with flexible dies (patents applied for) which follow the grooves in stationary dies. Such dies are especially necessary in making automobile arm rests and frames for modernistic furniture where the bending does not always lie in one plane. Where right- and left-hand parts are needed, one pair is formed at a time.

In bending to short radii, rods with balls on the ends are attached to the swinging arms. Before making the bend the operator, after clamping the tubes, inserts the ball-ended rods in the tubes and hooks these rods in notches in the ball puller. As the swinging arm, to which the wiping die cylinder is attached, moves around the stationary die the balls are pulled just back of the center line, ironing out the tubes to the full diameter in case they have flattened because of the short bend.

The accompanying illustrations are of machines developed for making automobile arm rests and seat frames. Fig. 1 shows a Type C machine that develops right-hand- and left-hand rear-seat, arm-rest supports at one cycle. The first valve at the left clamps two pieces of stock. The second valve operates the swinging arm carrying the first bending-die cylinder and forming about half of the bend. An air valve controls a cylinder that holds the second swinging arm raised out of the way to allow the above movement under it. The first bending cylinder is then backed away and the dies are clamped on the work, whereupon the third valve lowers the second wiping-die cylinder to the position illustrated. The fourth valve clamps the work between the wiping dies on the second cylinder and the stationary die, and the fifth valve swings the cylinder about the stationary die to complete the bend. From 60 to 80 pairs of arm rests are made per hour on this machine.

Fig. 2 shows a Type D machine that forms at one cycle both right- and left-hand arm rest supports for the front seat, performing the first operation only. The movements and operations are practically the same as those of the Type C machine, except that the stationary die is collapsible by hydraulic means, to permit removal of the finished piece. This machine forms 55 pairs of arm rests, first operation, per hour.

A Type E machine, not illustrated, finishes the front-seat arm rests and forms the support for the foot rest at the back of the front-seat frame. This machine finishes from 70 to 90 pairs per hour.

The front-seat back frame and robe rail are produced on a Type A machine shown in Fig. 3. Stock is inserted at the rear of the machine. The first valve clamps the stock and the back wiper dies, and the second valve operates both rear swinging arms, bringing the back wiper dies around to form a U-shape. Then the front end of the stock is pushed down into the front dies, where the third valve clamps the stock. The fourth valve operates the two front cylinders toward the operator, forming the curve on each side. The fifth valve swings back the bending dies for unloading. From 75 to 90 parts per hour are produced on this machine.

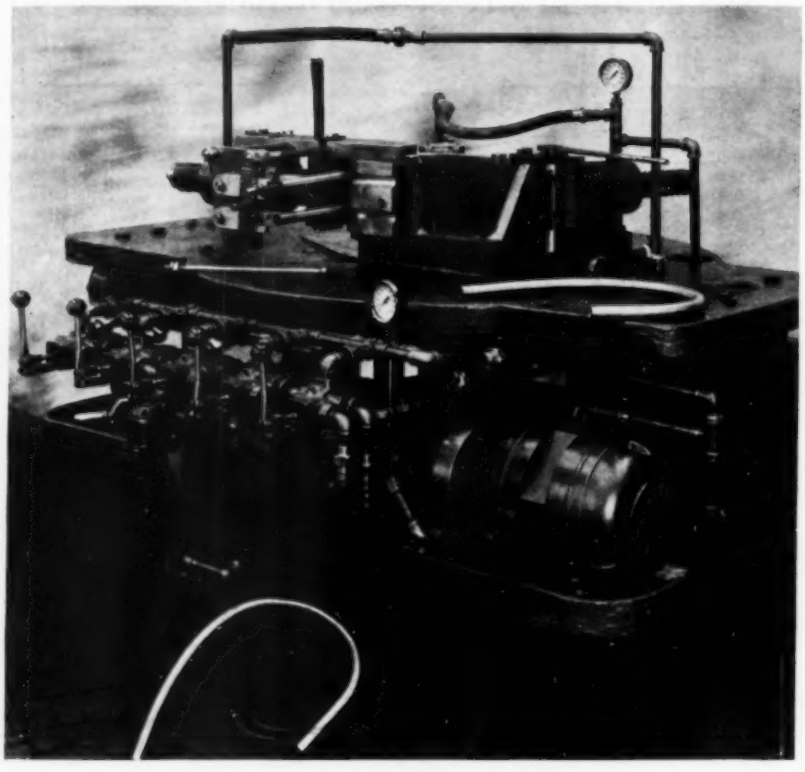


Fig. 1—One right-hand and one left-hand, rear-seat arm-rest support for an automobile are produced on this Type C bending machine per cycle

The front-seat back frame and robe rail for coach models is made on the machine shown in Fig. 4. The right-hand side of this machine forms the U-shape. The part is then transferred to the left side and finished. Both of these operations are carried out simultaneously and thus the machine produces one complete piece at each cycle. Production is about 60 to 70 pieces per hour.

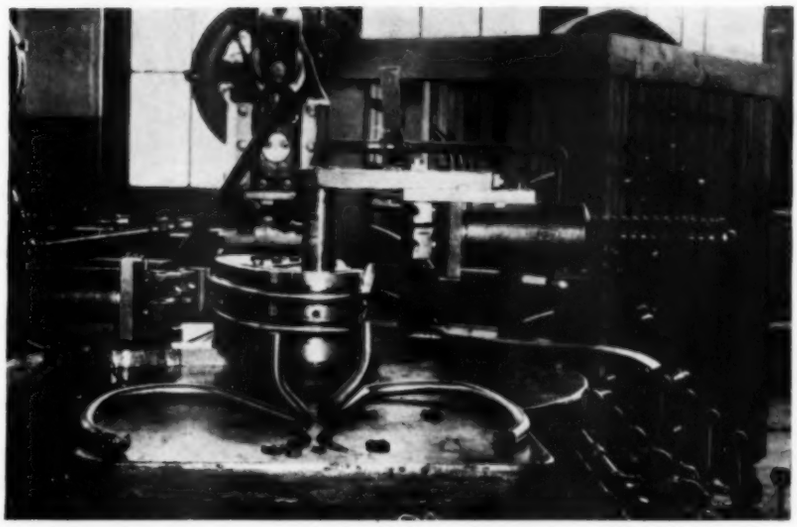


Fig. 2—Type D machine which forms front-seat armrest supports, first operation only. A right-hand and left-hand part are produced during the cycle

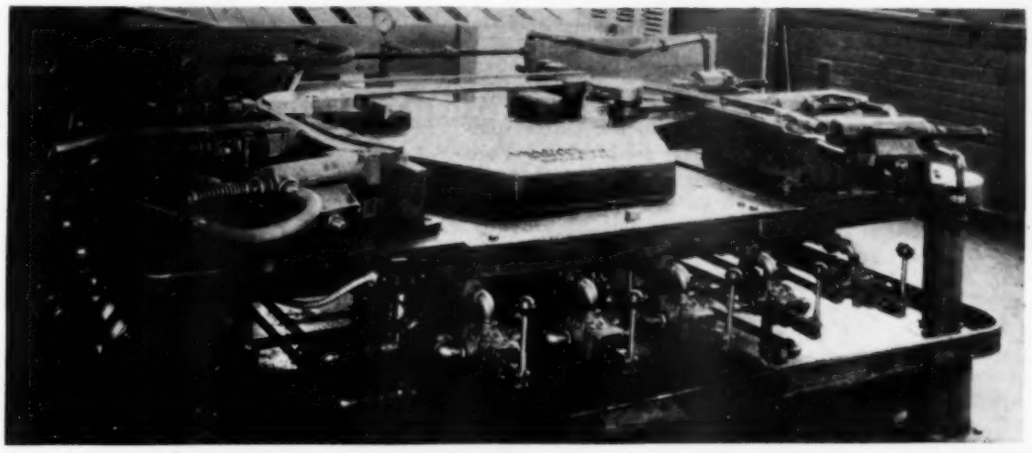


Fig. 3—The front-seat back frame and robe rail are made on this Type A machine at the rate of 75 to 90 parts per hour

Fig. 4—A front seat back frame for the coach model is started at the right-hand side, forming the U-shape, and then finished at the left-hand side

Producto-Matic No. 4 Thread and Cam Milling Machine

The Producto Machine Co., Bridgeport, Conn., has developed a No. 4 Producto-Matic thread and cam milling machine in which all functions are actuated from cams. The machine is built in a vertical fashion to conserve floor space and to permit easy access by the operator. Dimensions are 30 x 24 in. for the base, by 54 in. high. The two main movements of the machine are the vertical travel of the work slide and the

lateral movement of the cutter slide, both slides being actuated by separate cams.

For thread milling the work slide is moved vertically to bring the work in relation to the cutters, and to draw the slide away for convenience in loading. The cutter slide moves in a lateral direction to give the exact lead, which is secured by the movement of the cam. Multiple-point cutters can be used to complete the thread in one revolution of the work spindle. The work slide is 33 in. long by 10 in. wide. A mechanism for depth of thread adjustment is provided with a micrometer dial to adjust the work slide to the exact position. The work spindle is 2½ in. in diameter by 14 in. long and is driven by a worm and worm gear. Maximum stroke is 3 in.

The cutter spindle slide measures 33 in. x 12 in. The cutter spindle bearing is mounted on the slide and is made to swivel 12 deg. right or left hand to secure the cutting angle required. A No. 10 B. & S. taper is provided on one end of the spindle, and it is threaded on the other end for nuts to take up for wear.

Movement of the cutter slide assembly is actuated by a cam in the upper part of the accompanying illustration. An adjusting screw with micrometer dial gives the necessary adjustment to provide the proper positioning of the cutter. Maximum lateral movement is 2 in. Thread diameter milled is 4 in. as a maximum.

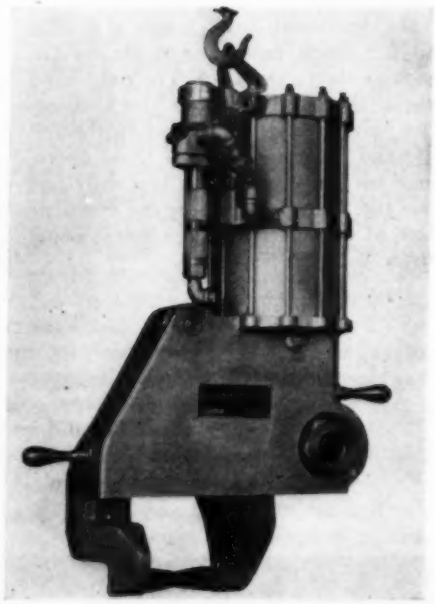
The drive is secured from a motor using two V-belts, one to the cutter spindle and one to the feed drive. Feed is controlled by one lever which operates the clutch to disengage the travel of the work slide in any position. However, the feed disengages automatically after the camshaft has made one complete revolution.

A tailstock for supporting the work on the outer end can be furnished and may be operated either automatically or by hand. An automatic chucking mechanism, including automatic clamping of the work, can be supplied.

For producing cams or other profile or contour work, the operation of the cutter and work slides permits the reproduction of any unusual surface from a master cam. The work slide follows the master cam mounted on a shaft at the lower position. As the slide is free to move vertically and the roller rests on the master cam, the exact form can be reproduced. Box or path-type cams can also be milled, using end mills. Maximum diameter for cam milling is 8 in.

Hanna Alligator-Type Squeeze Riveter

The Hanna Engineering Works, 1765 Elston Ave., Wicker Park Station, Chicago, Ill., has developed a light compact squeeze riveter of the alligator or nutcracker type. The machine illustrated develops 20 tons between the dies which is sufficient for heading ⅜-in. rivets cold and ⅝-in. rivets hot. The die stroke is 2 in. Both jaws of the alligator type riveter can be entered into a pocket or pockets to head a rivet which could not be reached by another type



The jaws of this Hanna Riveter can work in pockets

of machine. Considerable variation in the reach and shape of these jaws is possible. The mechanism is entirely inclosed and consists of a roller and toggle that transmit the power movement of the cylinder piston unit to the moving die in such a manner that the latter is closed upon the rivet with a minimum power consumption, but exerts a predetermined tonnage on the dies regardless of the variation in length and thickness of rivet.

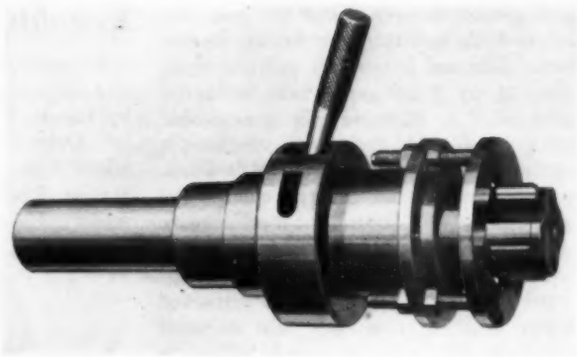
Murchey Type "C" Collapsible Taps

The Type C standard collapsible machine and pipe taps offered by the Murchey Machine & Tool Co., Detroit, Mich., may be used as stationary taps with the handle in place, or rotating taps with the handle removed. A single set of chasers may be used for both taps. Collapsing of the tap is done by rollers on a cam. The chasers are hooked onto the center pin with hardened slots to insure positive collapse, and they may be removed without removing the cap. Sizes from 1¼ in. to 12 in. are available.

These taps can be equipped with overhanging chasers to cut close to a shoulder or to be used in a blind hole. They may be constructed to include boring, reaming and chamfering tools, and they may also be made with any type of pilot. The trip ring may be adjusted to cut any length of thread desired within the capacity of the tap.

Type C taps are collapsed by means of a hardened tripping ring coming in contact with the work. This contact releases the roller from its bearing on the

The handle of this Murchey Type "C" Collapsible Tap can be removed to allow use as a rotating tap. Chaser adjustment is from the front end



cam, forcing the center pin backward. This action, due to the chasers being held in the T slots on the hardened and ground center pin, causes them to collapse positively. Chasers are expanded by means of a lever handle in a non-rotating tap or by a sliding collar in the case of the rotary tap. Adjustment for size is accomplished by an internal adjustment from the front end of the tap. This adjustment allows for $\frac{3}{64}$ in. over or below normal chaser size, and can be utilized to compensate for loss of size due to grinding.

"Coulter" Profile-Milling Machine

The Automatic Machine Co., Bridgeport, Conn., has adapted one of its standard machines to perform a special profile-milling operation. The operation requires the cutting of elongated grooves, tapered in width and depth, in chrome-molybdenum clutch disks, as shown in Fig. 2. The grooves had to be exactly duplicated in pairs, and right and left hand to match. One machine was required to cut four grooves and another machine to cut six grooves in each disk. The cutters used were high-speed die cutters of the fish-tail type running at 2,400 r.p.m., and held in precision collet chucks. Up and down location of the cutters is adjustable.

The work-holding spindles run right and left hand and are driven by a worm shaft and gears. Stopping of the operation at the end of the last cut is controlled by the limit switch in front, actuated by a knob on the left hand holding spindle.

A 2-hp. motor at the top rear of the column drives the vertical power shaft on which the V-belt drive pulley for the spindle is mounted. At the bottom of the vertical power shaft is mounted a worm and worm gear in which is incorporated a clutch actuated by a solenoid. The worm and worm gear drive the horizontal shaft through the clutch. This shaft in turn drives another worm shaft and gear to the cam shaft, on which, inside the housing, is mounted a cam that controls the vertical movement of the slide holding the cutter spindles. On the outside of the machine and on the end of the cam shaft are mounted bevel gears driving through the short angular shaft and another pair of bevels to the work-holding fixture. In the machine for the four-grooved disk, the work-holding spindles revolve once to four revolutions of the cam shaft, and with the six-grooved disk, the work spindle revolves once to six revolutions of the cam shaft.

With the motor running, the work is placed in the fixture and the start button is pressed. The solenoid is released to permit the clutch to engage and drive the cam shaft and the work spindles. At the completion of one revolution, the limit switch is engaged by a knob on the left-hand work spindle to operate the solenoid, disengage the clutch and stop the work operation. Production is 60 pairs or 120 disks grooved per hour. The machine is adaptable to work of a similar nature. It occupies a floor space of 24x34 in. Weight is 1,750 lb.

Fig. 1—"Coulter" two-spindle machine adapted for cutting elongated grooves, tapered both as to width and depth, in clutch disks

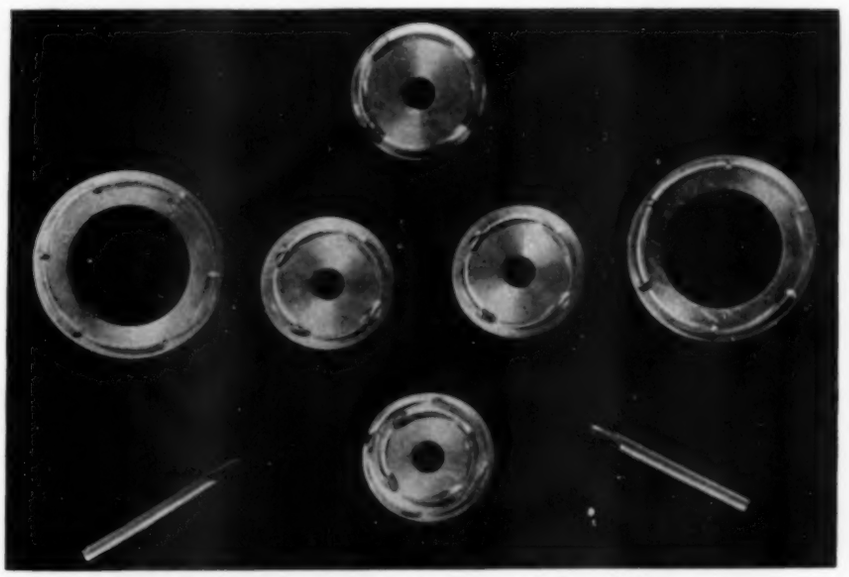


Fig. 2—Four-groove and six-groove disks which were profile-milled on the "Coulter" special-purpose profile-milling machine

Hutto Hone for Connecting-Rod Bearing Seats

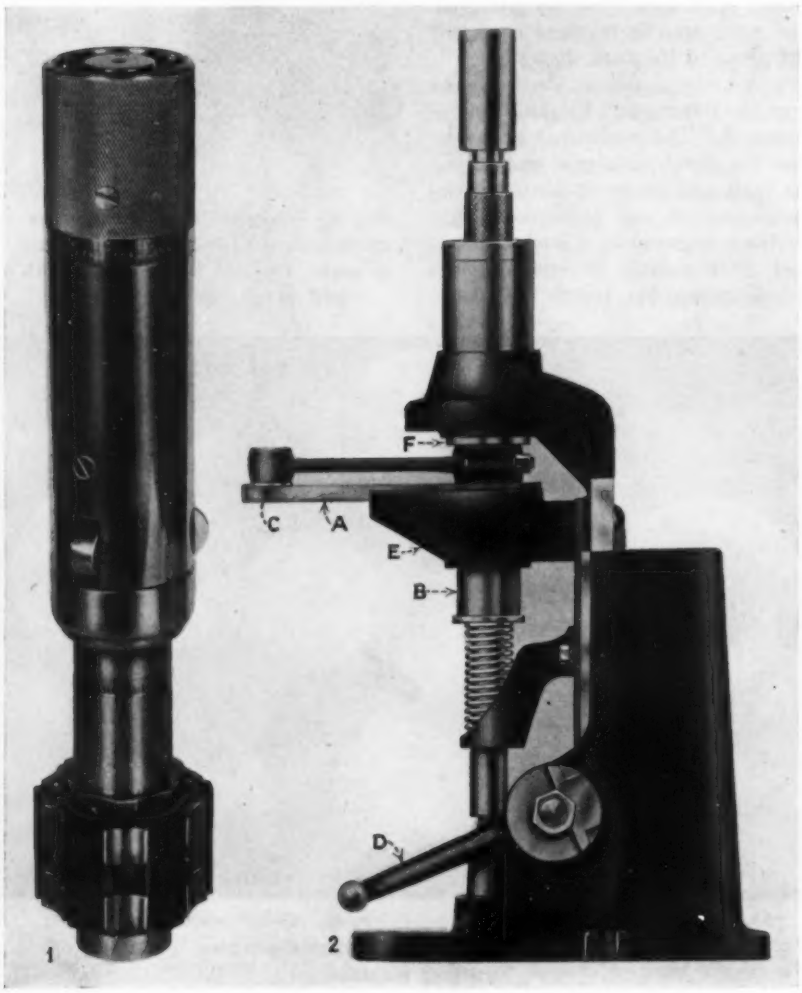
The Hutto Engineering Co., Inc., Detroit, Mich., has developed a hone for finishing connecting-rod bores as seats for the steel-backed babbitted bearings now in use on automobiles. The hone finishes only one rod at a time, because the company's experiments indicate that the most satisfactory work is achieved in this way.

The hone, Fig. 1, is expanded either automatically or by hand. Either method includes a micrometer adjustment that accurately predetermines the diameter of the finished bore. The hone "floats" in the connecting rod bore and the "universal" action of the abrasives in relation to the axis of the bore assures consistent cleaning up of the entire bore surface even when a small small amount of stock is removed. The "universal" movement overcomes the effect of lack of parallelism between the rod faces and their squareness to the nominal axis of the bore. Automatic control of the expansion of the abrasive stones prevents the possibility of honing oversize.

A special fixture, Fig. 2 has been developed to facilitate the honing operation. The rod is properly positioned on plate *A* by placing the bore over the pilot *B*. A flattened pin goes inside the pin hole at *C* and carries the torque of the hone. Moving the lever *D* downward raises the table *E* and clamps the rod lightly but securely between plate *A* and the lower end of bushing *F*, after which the rod and the table move upward together. The hone is contracted when entering the bore and expands automatically when inserted. The expansion ceases when the diameter for which the adjustment has been set is produced.

When the honing operation is completed, an upward movement of the lever *D* lowers the fixture; the hone automatically contracts and leaves the bore without scratching or marring the finish produced.

The fixture illustrated is only one of many types which may be adapted to this work and is notable for its simplicity and ease of operation. The pilot, plate, holding sleeve and guide bushing can be made interchangeable for the various sizes of connecting rods.



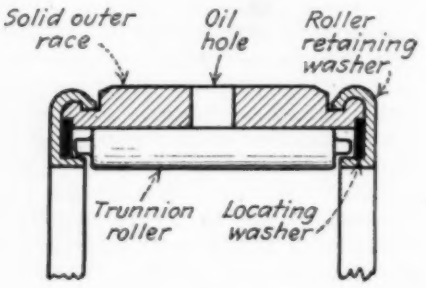
Rewoldt Bench Grinder

A single-wheel, V-belt driven bench grinder has been placed on the market by the H. C. Rewoldt Co., 38 Piquette St., Detroit, Mich. This grinder has a wheel 8 in. in diameter by 1 in. face, and is driven by a ¼-hp., 1,750-r.p.m. motor. The spindle speed is 2,800 r.p.m.,

and the equivalent surface speed of the wheel is 5,500 ft. per min. Seal-type ball bearings are applied. The wheel dressing arrangement can be clamped by hand without the use of tools, and this feature assures frequent light dressing for maximum wheel economy.

"20th Century" 7000 W Series Roller Bearings

The Roller Bearing Company of America, Trenton, N. J., has developed a "20th Century" roller bearing designed for maximum capacity within minimum space and suitable for high-speed operation. It is designed to eliminate the use of a retainer or cage, permitting the use of a full complement of rollers. The outer race is made from SAE 52100 steel, hardened and ground. Trunnion end-type rollers are used, retained in an inner area of the outer race by two cyanided roller retainer washers, which are knurled over the ends of the outer race and maintained in a fixed position. Hardened steel plates are interposed between the end rings and the ends of the rollers, to locate the position



of the rollers and to resist wear. Because of the intimate contact of the rolling elements the churning of lubricant is minimized.

The bearing is designed to operate on hardened and ground shafts. For shafts not adaptable to hardening the unit is used with an inner race made from SAE 52100 steel, hardened and ground. The bearing is built in shaft sizes from 0.50 to 5.00 in. Outside diameters are 1.00 to 6.00 in.

Davis Keyseater With Tilting Table

The Davis Keyseater Company, 399 Exchange St., Rochester, N. Y., is now building a keyseating machine with a tilting table so that both straight and tapered keyways can be cut in all kinds of bores. As shown, the machine is set up with a bushing and cutter in position for operation with the table horizontal. The table is pivoted, however, near the back end and is provided with an adjusting screw under the front end for raising or lowering it to any angle desired for cutting keyways in tapered bores up to a taper of approximately 3 in. per ft. A scale is provided to indicate the exact taper per foot. The cutter is maintained in a vertical position during all stages of the cutting operation and this fact facilitates set-up.

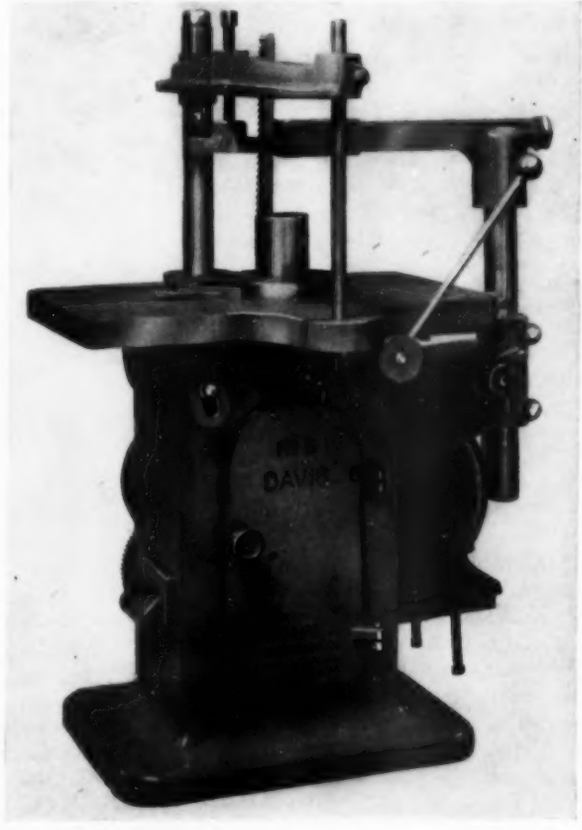
A saw or broach-type cutter having several teeth cutting at one time is employed. The cutter is fastened to a crosshead that gives it the reciprocating motion. The blank to be cut is set over a bushing, which is in turn clamped to the table by a suitable bushing holder. The piece to be keyseated is held down to the table by means of a swinging clamp bar.

Feed is of the table type, operated by hand lever. A stop is provided for stopping the movement of the table when the desired depth of cut has been reached. Motor drive can be applied easily.

Three sizes of machine are built. The No. 3 machine cuts keyways from ⅛ to ½ in.; No. 4 from ⅛ to 1 in. and No. 5 from ⅛ to 1½ in. Using a 15-in. cutter, the No. 3 machine will cut 4½ in. long, the No. 4, 4 in. long and the No. 5, 3½ in. long. With a 20-in. cutter the No. 3 machine will cut 4½ in. long, the No. 4, 8 in. long and the No. 5, 7½ in. long.

"Flexo-Dome" Lighting Fixture

The Wuelker Reflector-Lighting Corp., San Francisco, Calif., has placed on the market a "Flexo-Dome" lighting fixture for attachment to drill presses, lathes and other machine tools, to give adequate illumination at the work level, but to save the eyes of the operator from glare. The lighting unit is unaffected by motion or vibration and it is adjustable to any position. It is a jointed fixture, fire and waterproof, and having its own independent wiring system, equipped with socket and switch. An aluminum reflector and 150-watt bulb are supplied. The unit is provided with setscrews and stops so that it may be turned and adjusted easily, and held rigidly where required. This adjustable feature is of importance in the machine shop, since direction and placement of the light may be changed to suit the requirements of another job on the same machine whenever necessary. At the same time the operator's vision is not affected. Of course, the unit can also be mounted on work benches.



Davis Keyseating Machine with tilting table for cutting either straight or tapered keyways in all kinds of bores. Other operations besides keyseating can be done

• PATENTS •

MARCH 20, 1934

Metal-Working Machinery

Lathe or the Like. John E. Lovely, Springfield, Vt., assigned to Jones & Lamson Machine Co. Patent 1,951,514.

Machine Tool. Alfred Trosch, Rochester, N. Y., assigned to Consolidated Machine Tool Corp. of America. Patent 1,951,586.

Metal Swaging Machine. Charles T. Brennan, Cheshire, Conn. Patent 1,951,721.

Metal Swaging Machine. John E. Pracny, Waterbury, Conn., assigned to the E. J. Manville Machine Co. Patent 1,951,738.

Tools and Attachments

Tool and Method of Making the Same. Clarence W. Balke, Highland

Park, Ill., assigned to Ramet Corp. of America. Patent 1,951,856.

Work Holding Device. Kasimir Janiszewski, Milwaukee, Wis., assigned to Superior Tool & Die Co. Patent 1,951,869.

MARCH 27, 1934

Metal-Working Machinery

Grinding Machinery. John E. Caster, Frederick J. Theler and Gerald N. Barrere, Cincinnati, Ohio, assigned to Cincinnati Grinders Incorporated. Patent 1,952,157.

Grinding Machine. Benjamin R. Purvin, Cleveland, assigned to Cincinnati Grinders Incorporated. Patent 1,952,182.

Broaching Attachment. Alfred E. Drissner, Cleveland, assigned to the National Acme Co. Patent 1,952,194.

Automatic Profile Milling Machine. Gilbert V. Anderson, Philadelphia, Pa., assigned to the Cincinnati Milling Machine Co. Patent 1,962,230.

Milling Machine. Gilbert V. Anderson, Philadelphia, Pa., assigned to the Cincinnati Milling Machine Co. Patent 1,952,231.

Spindle Stop for Automatic Machines. Harry W. Rupple, Cleveland, Ohio, assigned to the Cleveland Automatic Machine Co. Patent 1,952,287.

Grinding Machine. Albert H. Dall and Hans Ernst, Cincinnati, Ohio, assigned to Cincinnati Grinders Incorporated. Patent 1,952,423.

Grinding Machine. Frederick S. Haas, Cincinnati, Ohio, assigned to Cincinnati Grinders Incorporated. Patent 1,952,432.

Abrading Machine. Dwight C. Page, Worcester, Mass., assigned to the Heald Machine Co. Patent 1,952,458.

Grinding Machine. Francis P. Brown, Providence, R. I., assigned to Brown & Sharpe Manufacturing Co. Patent 1,952,653.

Shearing Machine and Process of Shearing. Arthur T. Yates, West Seneca, N. Y., assigned to Buffalo Forge Co. Patent 1,952,961.

Automatic Lathe with Automatically Slidable Headstock. Andre Bechler, Moutier, Switzerland. Patent 1,952,966.

Machine Operating Device. George H. Smith, Worcester, Mass. Patent 1,953,029.

Tools and Attachments

Limit Gage. Frank O. Wells, Greenfield, Mass. Patent 1,952,190.

Circular Chaser Die Head. William J. Hogg, Cleveland, Ohio, assigned to the National Acme Co. Patent 1,952,205.

Device for Grinding Bottoms of Circular Chasers. William J. Hogg, Cleveland, Ohio, assigned to the National Acme Co. Patent 1,952,206.

Device for Grinding Pilot Holes in Circular Chasers. William J. Hogg, Cleveland, Ohio, assigned to the National Acme Co. Patent 1,952,207.

Holding Device for Chaser Blocks. William J. Hogg, Cleveland, Ohio, assigned to the National Acme Co. Patent 1,952,316.

Reaming Tool. Anton M. Vedoc, Quincy, Mass., assigned to Vedoe-Peterson Co. Patent 1,952,342.

Self-Opening Die-Head. Albert F. Breitenstein, New Haven, Conn., assigned to the Geometric Tool Co. Patent 1,952,743.

• TRADE • PUBLICATIONS

DIE STEEL—"Cromovan Triple Die Steel" is discussed in a four-page circular issued by the Firth-Sterling Steel Co., McKeesport, Pa. Information on characteristics, application, heat-treatment and machinability are given.

FURNACES—Pot and trough type electric furnaces are shown in Leaflet TD-20 being distributed by the Harold E. Trent Co., 618 North 54th Street, Philadelphia, Pa. Types of heating elements employed and the specifications are listed.

FURNACES—Model W electric furnaces for hardening high-speed steel are shown in a Bulletin 1018 available from the Sentry Co., Foxboro, Mass.

GAGES—Profile gages, what they are and their many uses are shown in a circular available from the Stockton Profile Gauge Corp., 165 Jackson St., Lowell, Mass. Gages are of laminated strip held in place by a flat bar and are capable of individual lengthwise displacement for taking the contour of a part.

GRINDERS—Its precision tool-room surface grinder is described by the Monarch Machine Tool Co., Sidney, Ohio, in a two-color catalog that incorporates a number of highly dramatized illustrations. The catalog pictures several views of this machine, the automatic force-feed lubrication feature, and a number of tests which illustrate the accuracy and smoothness of the work.

GRINDERS—Catalog No. H-34, issued by the Landis Tool Co., Waynesboro, Pa., describes the Type B, 16- 20- 24- 28-in. hydraulic roll grinding machines. Principal assemblies are illustrated, each is described and the specifications are listed.

LIGHT-METAL DATA—The Dow Metal Division, The Dow Chemical Co., Midland, Mich., has published a new edition of the "Dow Metal Data Book," bringing up to date the information on available forms of the material and also data on shop practice. Forms available include standard die castings, extruded shapes, forgings, sheet, plate and strip. Methods of welding, riveting, forming and machining are discussed in detail.

MOTORS—Three publications of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., describe fractional-horsepower motors. Leaflet 20606 describes Type FS polyphase squirrel-cage motors, two and three phase, 1/8 to 3/4 hp.; Leaflet 20604 describes Type FR repulsion-start induction motors for high torque, constant-speed service, 110-220 volts, 1/8 to 3/4 hp.; Leaflet 20605 describes Type FK direct-current motors for shunt-compound and series-wound service, 32, 115 and 230 volts, 1/30 to 3/4 hp.

SHAFTING—The Union Drawn Steel Company, Massillon, Ohio, published a booklet, "Union Cold Finished Shafting," showing the various grades of shafting available and typical uses.

TAPS AND DIES—The S. W. Card Mfg. Co., Mansfield, Mass., has published Catalog No. 33, said to have the latest listing and correct tables of dimensions, limits and tolerances.

WELDING TIMER—Leaflet 20616, issued by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., describes the "Ignitron" welding timer for spot welding. The distinctive features, construction, operation and application are described.

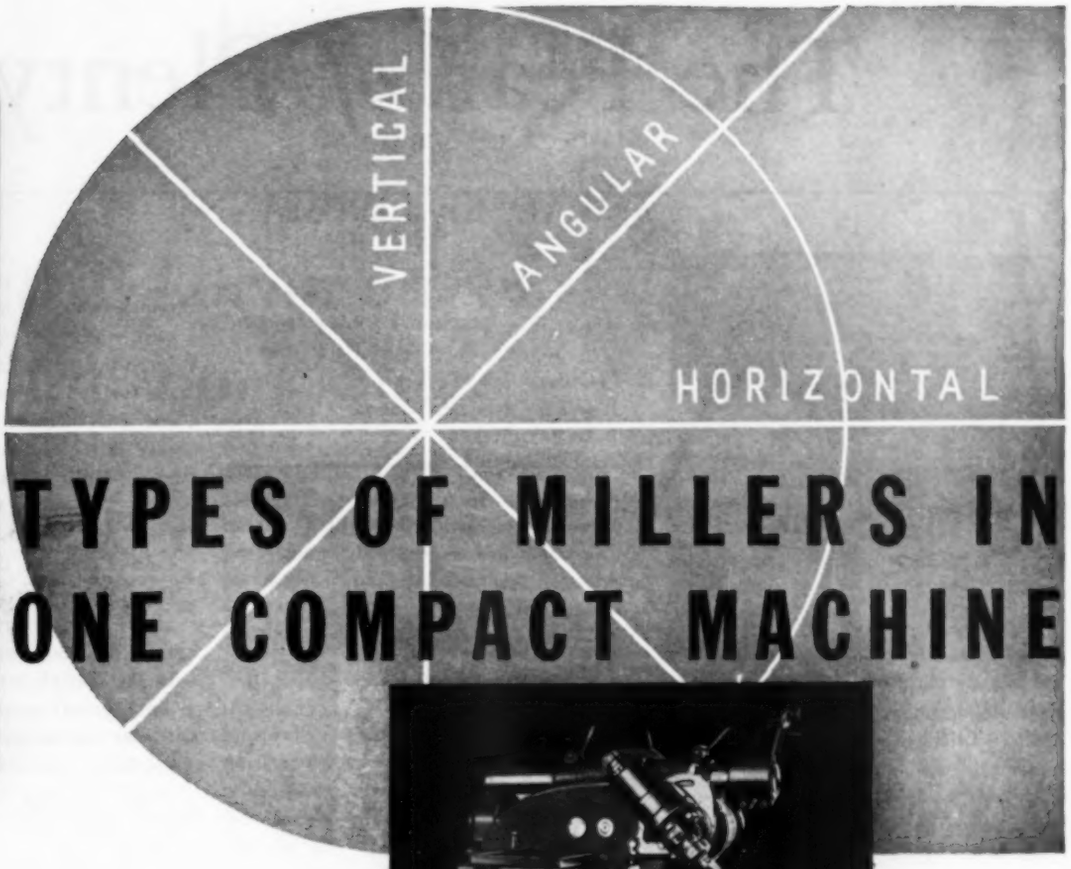
IMPACT TESTING OF CAST IRON—The American Society for Testing Materials, 260 South Broad St., Philadelphia, Pa., has published a report "Impact Testing of Cast Iron" which contains one of the most comprehensive series of data ever assembled on the physical properties of this material. Copies of the report, can be obtained at 50 cents each.

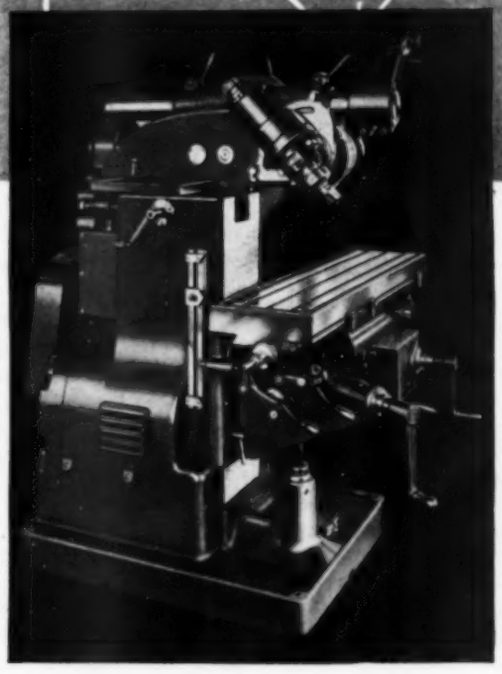
• EXPORT • OPPORTUNITIES

The Ashida Engineering Co., Daini, Sagisucho, Osaka, Japan, desires to represent makers of precision instruments, small tools and machinery in Japan. Catalogs, prices and other details should be sent direct to the company.

J. E. Jacob, 2nd Cross Street, Jaffua, Ceylon, wants catalogs of steam engines, boilers and machinery for a medium-sized laundry; also, a catalog of flour milling machinery to mill 200 lb. of rice per hr. He wants to know whether wet rice can be milled.

3 TYPES OF MILLERS IN ONE COMPACT MACHINE





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Put an end to men waiting their turn for milling machines that perform only one type of milling operation. The Van Norman Miller with its swiveling cutter head and sliding ram provides all the advantages of vertical, angular and horizontal millers *in one sturdy, compact machine.*

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The Fear *of* Plenty

by WALTER LIPPMANN

American Machinist acknowledges with thanks the New York Herald Tribune's permission to reprint this article by Mr. Lippmann.

THE other day in the House of Representatives a Congressman was explaining why he favored the Bankhead bill, which would make it a criminal offense to produce more than the allotted amount of cotton. He had returned recently, he said, to a farm in central Kansas where he worked as a boy, and there he saw three men using machinery to harvest a crop that once would have required thirty men. "This is the picture of mass production by machinery in wheat. The harvest hand is gone. The cotton picker is going. Cows are milked by machinery. Printing is a dying trade. Telephones are self-operative. Accounts are kept by machinery. The machinery is self-created. It digs its own materials out of the ground, transports them to the manufacturing plant, manufactures itself and operates itself. Every day in every way, on the farm, in the factory, in the mine, the need for human labor becomes less and less."

The Congressman has stated a view which is widely held at the present time. It is at the root of the multitudinous efforts being made to limit production and create an artificial scarcity in the midst of what is felt to be an overwhelming abundance. Is there anything wrong with the Congressman's statement and, if so, what is it?

IT is not difficult, I think, to show that there is something fundamentally wrong with it. If labor-saving machinery produces unemployment, there ought to be some relation between the amount of unemployment and the amount of labor-saving machinery. Now, a few years ago Mr. T. T. Read made what is supposed to be the best available estimate of the world's output of work based upon the amount of mechanical and human energy used in different countries. The calculation was made in 1926. At that time the United States had a work output per capita which was one and a half times that of Great Britain, two and a half times that of Germany, nearly forty times that of China, India and Russia. But at the same time, in 1926, the United States was prosperous. In England and Germany there was serious unemployment, and in Russia, China and India a desperately low standard of life. If the theory that labor-saving machinery is the cause of unemployment were correct, we should have had in 1926 nearly three times the amount of unemployment there was in Germany. In fact we had much less.

What is more, if the theory were correct, we should have had ever-increasing unemployment for the past hundred years. For there has been a prodigious increase in labor-saving machinery. But the fact is that, except temporarily during depressions, we have employed more and more people at higher real wages throughout that period. The explanation is not difficult to find. Take the Congressman's wheat farm, where three men do the work that thirty did when he was a boy. By dint of a little research in the Congressional Directory I find that the Congressman did his farming from 1884 to 1894. In 1894 the country produced 634,000,000 bushels of wheat and in 1929 it produced 813,000,000 bushels, an increase of about 30 per cent in a period when the population increased about 70 per cent. So, in 1894, the country was producing about nine bushels per capita and in 1929 a little less than seven. Wheat production was actually declining. But with the aid of labor-saving machinery the individual farmer was producing more wheat. That machinery has to be made out of something. In that same period the production of pig iron multiplied seven times. To make that machinery requires fuel. In that period the production of coal multiplied three and a half times. The machinery requires fuel to operate it. In that period the production of petroleum multiplied forty times.

That is the answer to the Congressman's argument. The three men on the farm who use machinery were not the only ones working to harvest that crop. Behind them, but out of sight, were the miners who dug the ore and the coal, the men who made the steel and manufactured the machines, the men who produce the fuel to run them, who transported and serviced them. It may not any longer take thirty men to do the work of three men, but it takes many more than the three. When the Congressman exclaimed that "the machine is self-created" he showed what his illusion is. The machine is not self-created. A tractor which displaces twenty-seven men on a Kansas farm does not displace twenty-seven men in the United States. It takes many of those twenty-seven men to produce the tractor and keep it running. A few are displaced, presumably on the average about one man in fifty per year, since total production tends to increase about 2½ per cent a year. That labor power can either be directed to increased leisure or used to produce more wealth. For the country as a whole and in the long run the problem of technological unemployment, so called, cannot be of a much greater order of magnitude than this.

THE idea that labor-saving machinery makes a nation poorer is a most curious but persistent illusion. In the unsettled parts of Africa, according to Mr. H. Foster Bain, a man carries on his back about sixty pounds of food and eats two pounds a day. That means that he can go forward fifteen days and have enough food to get back alive. Now you can say, if you like, that this means work for everybody. But it really means poverty and the risk of starvation for everybody. In 1902 a man went deep into Africa to study the copper deposits of the Belgian Congo. It required five thousand men on his line of supply to take care of him, and even then he had to hurry to avoid a food shortage. That is what the lack of labor-saving machinery means. The mere task of carrying enough food for him and for the men who were carrying the food required a small army. That is one way to make employment. But it is not the way to raise the standard of life, and yet that is precisely what will be accomplished if those who are haunted by the specter of overproduction are allowed to translate their delusion into public policy.